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INSTITA D MDCCCLXXX

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WITHDRAWN

TRANSACTIONS

OF THE

AMERICAN SURGICAL ASSOCIATION

ROYAL SOCIETY OF MEDICINE
15 OCT 1920

VOLUME THE THIRTY-SEVENTH

EDITED BY

JOHN H. JOPSON, M.D.
RECORDER OF THE ASSOCIATION

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CONTENTS

Officers of the Association vi
List of Presidents of the Association viii
Fellows of the Association xi
Senior Fellows xxxii
Honorary Fellows xxxiv
Deceased Fellows xxxvi
Report of the Committee on Necrology xli

The Influence of War Surgery upon Civil Practice. By Lewis Stephen Pilcher, M.D. 1
General Considerations as to the Treatment of War Wounds. By Antoine Depage, M.D. 15
The Most Important Factor in the Treatment of War Wounds and the Most Important Factor in Civilian Surgery—the Good Surgeon. By George W. Crile, M.D. 35
The Problem of the "Slightly Wounded" in Military and Civilian Practice. By William E. Lower, M.D. 38
What Would be the Benefit to the Civilian Surgeon in the Experience Gained by Our Military Surgeons in the Recent World War? By Edgar A. Vander Veer, M.D. 44
The No-flap or Guillotine Amputation: An Unfortunate Resurrection. By John H. Gibbon, M.D. 52
Treatment of Recent Wounds of the Knee-joint. By Eugene Hillhouse Pool, A.B., M.D., and John H. Jopson, M.D. 61
Report of 82 Cases of Knee-joint War Injuries from Evacuation Hospital I, A. E. F. With Remarks on the Willems' Treatment by Immediate Closure and Subsequent Mobilization, and the Management of the Subsequent Infection by Drainage and Mobilizations. By Clarence A. McWilliams, M.D., and William B. Hetzel, M.D. 91
Transthoracic Laparotomy. By Willy Meyer, M.D. 106
The Treatment of Gunshot Wounds of the Chest. By Ellsworth Eliot, M.D. 123
Thoracic Fistula and Chronic Empyema, a Non-deforming Operation for its Cure. By Howard Lilienthal, M.D. 134

The Delayed or Late Extraction of Intrathoracic Projectiles by the Method of Petit de la Villéon. By ROBERT G. LE CONTE, M.D. . 146

Fractures of the Lower Third of the Femur. By JOSEPH VAN DE VELDE, M.D. 162

Phases of War Surgery. Bone Transplants from the Tibia to the Lower Jaw for Loss of Substance. By CHARLES A. POWERS, M.D. 166

Cranioplasty. The Value of a Graft of Bone Cartilage or Fascia in the Closure of Cranial Defects Caused by Wounds in War. A Study of the Results Obtained in a Series of Forty-two Operations. By ALEXANDER PRIMROSE, C.M. 174

Notes on Stumps and Amputations. By FREDERICK J. COTTON, M.D. 210

Surgical Problems in the Reconstruction of Peripheral Nerve Injuries. By CHARLES H. FRAZIER, M.D. 226

Salvage of the Hand by Timely Reparative Surgery. By JOHN B. ROBERTS, M.D. 242

A Case in which for Over Thirty-five Years a Woman Defecated and Urinated, and for Eleven Years Menstruated by the Rectum. By WILLIAM W. KEEN, M.D. 258

Congenital Arteriovenous and Lymphaticovenous Fistulæ: Unique Clinical and Experimental Observations. By WILLIAM STEWART HALSTED, M.D. 262

Further Observations on the Conservative Treatment of Sarcoma of the Long Bones. By WILLIAM B. COLEY, M.D. 273

The Organization and Operation of an Evacuation Hospital. By DEAN LEWIS, M.D., and THOMAS J. LEARY, M.D. 337

Foreign Bodies in the Stomach. By RANDOLPH WINSLOW, M.D. . . 355

Operative Treatment of Peptic Ulcer; Removal of Ulcer with Gastro-enterostomy, or Gastro-enterostomy Alone. By JOHN B. DEAVER, M.D. 367

Life Expectancy of Patients following Operations for Gastric and Duodenal Ulcer. By DONALD C. BALFOUR, M.D. 372

Cancer of the Stomach and Its Surgical Treatment. By CHARLES H. MAYO, M.D. 378

Experimental Hydrocephalus. By WALTER E. DANDY, M.D. . . . 397

An Analysis of the Results of Six Years' Follow-up System in a Surgical Service. By C. L. GIBSON, M.D. 429

The Transplantation of the Rectus Muscle or Its Sheath for the Cure of Inguinal Hernia when the Conjoined Tendon is Obliterated, and the Transplantation of the Sartorius Muscle for the Cure of Recurrent Hernia when Poupart's Ligament has been Destroyed By JOSEPH COLT BLOODGOOD, M.D. 463

Postinfluenzal Abscess of the Sheath of the Rectus Muscle. By HOMER GAGE, M.D. 476

The Results of Splenectomy in the Anemias. By WILLIAM J. MAYO, M.D. 483
Traumatic Facial Diplegia. By JOSEPH RANSOHOFF, M.D., F.R.C.S. (ENG.) 494
Lantern Slide Demonstration of Jaw Surgery. By ANTOINE DE PAGE, M.D. 505
Possible Advances in Civil Medicine Suggested by Experiences in Treating War Injuries of the Chest. By J. L. YATES, M.D. . . . 506
Report of the Committee on Necrology xli
Mears, James Ewing
Kocher, Theodor
Davis, Gwilym George
Moore, James Edward

OFFICERS OF THE ASSOCIATION

ELECTED JUNE, 1919

PRESIDENT

GEORGE E. BREWER, M.D.

VICE-PRESIDENTS

JOHN F. BINNIE, M.D.
ALEXIS CARREL, M.D.

SECRETARY

JOHN H. GIBBON, M.D.,
1608 Spruce St., Philadelphia.

TREASURER

CHARLES H. PECK, M.D.,
30 West Fiftieth St., New York City.

RECORDER

JOHN H. JOPSON, M.D.,
1824 Pine Street, Philadelphia, Pa.

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CHARLES H. PECK, M.D.
JOHN H. JOPSON, M.D.
} *Ex-officio.*

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RECORDER, SECRETARY AND TREASURER, *ex-officio.*

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PRESIDENT, SECRETARY, RECORDER AND THE CHAIRMAN OF THE ADJUNCT LOCAL COMMITTEE OF ARRANGEMENTS, *ex-officio.*

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(Report by Title.)

JOHN B. ROBERTS, M.D., *Chairman*
ARPAD G. GERSTER, M.D.
CHARLES N. DOWD, M.D.

Place of next meeting:
ST. LOUIS, MO.

ADJUNCT LOCAL COMMITTEE OF ARRANGEMENTS

HARVEY G. MUDD, M.D.
JOHN F. BINNIE, M.D.
MAJOR G. SEELIG, M.D.

LIST OF THE PRESIDENTS

OF THE

ASSOCIATION FROM THE TIME OF ITS INSTITUTION

ELECTED

1880. †SAMUEL DAVID GROSS, M.D., LL.D., D.C.L (Oxon.), LL.D. (Cantab.), LL.D. (Edin.)—Founder of the Association.
1883. †EDWARD MOTT MOORE, M.D., LL.D.
1884. †WILLIAM THOMPSON BRIGGS, M.D.
1885. †MOSES GUNN, A.M., M.D., LL.D.
1886. †HUNTER McGUIRE, M.D., LL.D.
1887. †D. HAYES AGNEW, M.D., LL.D.
1888. †DAVID WILLIAMS CHEEVER, M.D., LL.D.
1889. †DAVID W. YANDELL, M.D.
1890. †CLAUDIUS HENRY MASTIN, M.D., LL.D.
1891. †PHINEAS SANBORN CONNER, M.D., LL.D.
1892. †NICHOLAS SENN, M.D., Ph.D., LL.D.
1893. †JAMES EWING MEARS, A.M., M.D., LL.D.
1894. FREDERIC SHEPARD DENNIS, M.D.
1895. †LOUIS McLANE TIFFANY, A.M. (Cantab.), M.D.
1896. JOHN COLLINS WARREN, M.D., LL.D. (Jefferson) Hon. F.R.C.S. (Eng.).
1897. †THEODORE F. PREWITT, M.D.
1898. WILLIAM W. KEEN, A.M., M.D., LL.D., Hon. F.R.C.S. (Eng. and Edin.).
1899. ROBERT F. WEIR, A.M., M.D., Hon. F.R.C.S. (Eng.).
1900. †ROSWELL PARK, M.D.
1901. †DE FOREST WILLARD, A.M., M.D., Ph.D.
1902. †MAURICE H. RICHARDSON, A.B., M.D.
1903. †NATHANIEL P. DANDRIDGE, M.D.
1904. †GEORGE BEN JOHNSTON, M.D.
1905. ALBERT VANDER VEER, M.D.
1906. †DUDLEY P. ALLEN, M.D., LL.D.
1907. WILLIAM H. CARMALT, M.D.
1908. C. B. G. de NANCRÈDE, A.M., M.D., LL.D.

† Deceased.

ELECTED

1909. RUDOLPH MATAS, M.D.
1910. RICHARD H. HARTE, M.D.
1911. ARPAD G. GERSTER, M.D., CHIR.D.
1912. CHARLES A. POWERS, A.M., M.D.
1913. WILLIAM J. MAYO, A.M., M.D., D.SC., F.R.C.S. (EDIN.), LL.D. (TOR.).
1914. GEORGE E. ARMSTRONG, C.M., M.D.
1915. ROBERT G. LE CONTE, A.B., M.D.
1916. SAMUEL J. MIXTER, S.B., M.D.
1917. THOMAS W. HUNTINGTON, A.B., M.D., LL.D.
1918. LEWIS S. PILCHER, A.M., M.D., LL.D.
1919. GEORGE E. BREWER, M.D.

NOTICE

This volume of TRANSACTIONS contains the papers read before the Association at the Meeting held June 16, 17 and 18, 1919.

The Association assumes no responsibility for the statements and opinions published in this volume.

FELLOWS

OF THE

AMERICAN SURGICAL ASSOCIATION

JUNE, 1920

* Denotes Original Fellows.
† Denotes Senior Fellows.
‡ Denotes Deceased Fellows.

ELECTED

†1890. ABBE, ROBERT, M.D., 13 West Fiftieth Street, New York. Senior Surgeon to St. Luke's Hospital. *Vice-President*, 1901. *Council*, 1908.

†1890. ALLIS, OSCAR HUNTINGTON, A.M., M.D., 1604 Spruce Street, Philadelphia. Surgeon to the Presbyterian Hospital.

1902. ANDREWS, E. WYLLYS, A.M., M.D., 122 S. Michigan Avenue, Chicago, Ill. Professor of Surgery, Northwestern University Medical School; Surgeon to St. Luke's Hospital and Michael Reese Hospital; Surgeon-in-Chief to Cook County Hospital; Consulting Surgeon to the Provident Hospital.

1916. ARCHIBALD, EDWARD WILLIAM, B.A., M.D., C.M., 160 Metcalfe Street, Montreal, Canada. Lecturer in Clinical Surgery, McGill University; Assistant Surgeon, Royal Victoria Hospital; Associate Surgeon, Children's Memorial Hospital.

1901. ARMSTRONG, GEORGE E., M.D., C.M., C.M.G., LL.D. (Queens), D.Sc. (Liverpool), 320 Mountain Street, Montreal. Professor of Surgery and of Clinical Surgery, McGill University; Chief Surgeon to the Royal Victoria Hospital, Consulting Surgeon to the Montreal General Hospital, the Western Hospital and to the Protestant Hospital for the Insane, Verdun; Colonel, C.A.M.C. *President*, 1914.

ELECTED

1913. Ashhurst, Astley Paston Cooper, A.B., M.D., 1629 Spruce Street, Philadelphia. Instructor in Surgery in the University of Pennsylvania; Surgeon to the Episcopal Hospital; Surgeon to the Philadelphia Orthopædic Hospital and Infirmary for Nervous Diseases; Colonel, Medical Reserve Corps, U. S. Army.

1917. Balfour, Donald Church, M.B., M.D., Rochester, Minn. Associate Professor of Surgery, University of Minnesota; Surgeon to St. Mary's Hospital, Rochester.

1906. Barrow, David, M.D., 148 Market Street, Lexington, Ky. Surgeon to St. Joseph and Good Samaritan Hospitals; recently, Lieut.-Col., M.C.; Commanding Officer, Base Hospital 40.

†1882. Barton, James M., A.M., M.D., 32 North New Hampshire Ave., Atlantic City, N. J.

1915. Besley, Frederic A., M.D., F.A.C.S., 4515 Greenwood Avenue, Chicago, Ill. Professor of Surgery, Northwestern University Medical School; Attending Surgeon to the Mercy and Cook County Hospitals.

1900. Bevan, Arthur Dean, M.D., 122 S. Michigan Boulevard, Chicago. Professor and Head of the Department of Surgery, Rush Medical College, University of Chicago; Surgeon to Presbyterian Hospital.

1901. Binnie, J. F., M.A., M.B., C.M. (Aberdeen), 917 Rialto Bldg., Kansas City, Mo. *Vice-President*, 1907 and 1919.

1918. Blair, Vilray Papin, M.D., 4654 Pershing Ave., St. Louis, Mo. Professor of Oral Surgery, Washington University Dental School; Associate in Surgery, Washington University Medical School; Visiting Surgeon, St. Luke's Hospital; Assistant Surgeon in St. Louis Children's Hospital and Barnes Hospital.

1906. Blake, John Bapst, A.M., M.D., 657 Boylston Street, Boston, Mass. Assistant Professor in Surgery, Harvard Medical School; Surgeon-in-Chief to the Boston City Hospital; Consulting Surgeon to Long Island Hospital; Consulting Surgeon to Boston Insane Hospital; Consulting Surgeon to the Reformatory for Women, Framingham, Mass.

1902. Blake, Joseph A., M.D., 55 West 49th Street, New York, N. Y.

1901. Bloodgood, Joseph Colt, B.S. (Wisc., 1888), M.D. (Penna., 1891); office, 904 N. Charles St., Baltimore, Md.; residence,

ELECTED

18 Midvale Road, Roland Park, Md. Associate Professor of Clinical Surgery, Johns Hopkins University; Surgeon to St. Agnes's Hospital, Baltimore.

1901. BOSHER, LEWIS C., M.D., 422 East Franklin Street, Richmond, Va. Emeritus Professor of Genito-urinary Surgery and Practice of Surgery, Medical College of Virginia; Visiting Surgeon, Stuart Circle Hospital and Memorial Hospital.

1913. BOTTOMLEY, JOHN T., A.B., LL.D., M.D., 165 Beacon Street, Boston. Surgeon-in-Chief, Carney Hospital.

†1890. BRADFORD, EDWARD HICKLING, A.B., M.D., 133 Newbury Street, Boston. Surgeon to the Children's and the Samaritan Hospitals; Assistant Professor of Orthopedic Surgery, Harvard University.

1900. BREWER, GEORGE EMERSON, M.D., 16 East Sixty-fourth Street, New York City. Emeritus Professor of Surgery in College of Physicians and Surgeons, Columbia University; Consulting Surgeon to the Presbyterian Hospital, Rooseveldt, City, Woman's, St. Vincent's, Manhattan Eye, Ear, Nose and Throat Hospitals, and to the Ophthalmic and Aural Institute, New York; to the Muhlenberg Hospital of Plainfield, N. J., the Flushing and Perth Amboy Hospitals. *Vice-President*, 1913. *President*, 1919.

1917. BREWSTER, GEORGE W. W., A.B., M.D., F.A.C.S., 213 Beacon Street, Boston, Mass. Associate in Surgery, Harvard Graduate School; Visiting Surgeon, Massachusetts General Hospital; Consulting Surgeon to Frost Hospital, Chelsea, Mass.; Leonard Morse Hospital, Natick, Mass.; Milford Hospital, Milford, Mass.

1915. BRINSMADE, W. B., A.B., M.D., 172 Clinton St., Brooklyn, N. Y. Consulting Surgeon to St. Christopher's Hospital; Senior Surgeon, Brooklyn Hospital; Commander, U.S.N.R.F., M.C.

1911. BRUCE, HERBERT A., M.D. (Toronto Univ.), L.R.C.P. (London), F.R.C.S. (England), 64 Bloor Street East, Toronto, Canada. Associate Professor of Clinical Surgery, University of Toronto; Surgeon to the Toronto General Hospital; Colonel, Canadian Army Medical Corps and Royal Army Medical Corps; Late Consulting Surgeon to the British Armies in France.

1911. BUCHANAN, J. J., A.M., M.D., Ph.D., 1409 N. Highland Avenue, Pittsburgh, Pa. Emeritus Professor of Surgery, University of Pittsburgh; Surgeon to Mercy Hospital.

ELECTED

1900. BUNTS, FRANK E., M.D., 1021 Prospect Street, Cleveland, Ohio. Professor of Principles of Surgery and Clinical Surgery in Medical College of Western Reserve University; Visiting Surgeon and Chief of Staff to St. Vincent's Charity Hospital.

†1885. CARMALT, WILLIAM H., A.M., M.D., 261 St. Ronan Street, New Haven, Conn. Emeritus Professor of Surgery in Yale University; President and Consulting Surgeon to the New Haven Hospital. *President*, 1907; *Vice-President*, 1895; *Member of Council*, 1908.

1909. CARREL, ALEXIS, L.B., Sc.B., M.D., Rockefeller Institute for Medical Research, Sixty-sixth Street and Avenue A, New York, N. Y.

1896. CARSON, NORMAN BRUCE, M.D., 303 Humboldt Bldg., St. Louis, Mo. Surgeon to St. Louis, Mullanphy Hospital and to the St. Vincent Insane Asylum, etc. *Vice-President*, 1903.

1916. CODMAN, ERNEST AMORY, A.B., M.D., 227 Beacon St., Boston, Mass.

†1896. COLE, CHARLES KNOX, A.M., M.D., Helena, Montana. Surgeon to St. John's, St. Peter's, and County Hospitals.

1898. COLEY, WILLIAM B., M.D., 6 West Fiftieth Street, New York. Attending Surgeon to the Memorial Hospital; Associate Surgeon to the Hospital for Ruptured and Crippled, New York.

1914. COTTON, FREDERICK J., A.B., M.D., A.M., 520 Commonwealth Avenue, Boston, Mass. Visiting Surgeon to the Boston City Hospital; Associate in Surgery, Harvard School for Graduate Instruction in Medicine; Consultant in Surgery, United States Public Health Service, Northeastern District; also Consultant in Surgery, New England Hospital for Women and Children.

1905. CRILE, GEORGE W., M.D., 1021 Prospect Avenue, Cleveland, Ohio. Professor of Surgery, School of Medicine, Western Reserve University; Visiting Surgeon to Lakeside Hospital.

1906. CUSHING, HARVEY, A.M., M.D., ScD., LL.D., F.R.C.S., The Peter Bent Brigham Hospital, Boston. Professor of Surgery, Harvard University.

†1896. CUSHING, HAYWARD WARREN, A.B., M.D., 70 Commonwealth Avenue, Boston, Mass. Consulting Surgeon, Boston City Hospital.

ELECTED

1897. Da Costa, John Chalmers, M.D., 2045 Walnut Street, Philadelphia. Samuel D. Gross Professor of Surgery, Jefferson Medical College; Surgeon to the Hospital of the Jefferson Medical College; Consulting Surgeon to the Philadelphia General Hospital, Saint Joseph's Hospital and Misericordia Hospital.

1917. Darrach, William, A.B., M.A., M.D., 19 East 65th Street, New York City. Associate Professor of Surgery and Dean of the Medical Faculty, College of Physicians and Surgeons, Columbia University; Consulting Surgeon, Memorial Hospital, Morristown, N. J.

1916. Davis, Carl B., A.B., M.D., 122 South Michigan Boulevard, Chicago, Ill. Assistant Professor of Surgery, Rush Medical College; Associate Surgeon, Presbyterian Hospital, Chicago.

1917. Davis, John Staige, Ph.B., M.D., F.A.C.S., 1200 Cathedral Street, Baltimore, Md. Instructor in Clinical Surgery, Johns Hopkins University; Visiting and Plastic Surgeon, Union Protestant Infirmary, Hospital for the Women of Maryland, Children's Hospital School; Assistant Visiting Surgeon and Dispensary Surgeon, Johns Hopkins Hospital.

1919. Davis, Lincoln, A.B., M.D., 217 Beacon St., Boston, Mass. Associate in Surgery, Harvard Graduate School of Medicine; Visiting Surgeon, Massachusetts General Hospital; Consulting Surgeon, Massachusetts Charitable Eye and Ear Infirmary, Heywood Memorial Hospital, Gardner, Milford Hospital, Milford.

1912. Deaver, Harry C., M.D., 1701 Spruce Street, Philadelphia. Professor of Surgery, Woman's Medical College of Pennsylvania; Surgeon-in-Chief to Kensington Hospital for Women; Surgeon to the Episcopal Hospital and to the Children's Hospital of the Mary Drexel Home.

1892. Deaver, John B., M.D., Sc.D., LL.D., 1634 Walnut Street, Philadelphia. John Rhea Barton Professor of Surgery, University of Pennsylvania, Philadelphia; Surgeon-in-Chief to the Lankenau Hospital, Philadelphia.

1910. Delatour, H. Beeckman, M.D., 73 Eighth Avenue, Brooklyn, N. Y. Attending Surgeon, St. John's and Norwegian Hospitals; Consulting Surgeon, Kingston Avenue Hospital, Brooklyn, St. Mary's Hospital, Jamaica, and Northport Hospital.

†1882. Dennis, Frederic Shepard, M.D., F.R.C.S. (Eng.); 62 East Fifty-fifth Street, New York. Professor Emeritus of Clini-

ELECTED

cal Surgery, Cornell University, New York City; Consulting Surgeon to the Bellevue and Attending Surgeon to St. Vincent's Hospitals; Consulting Surgeon to St. Joseph's Hospital, Yonkers, and Montefiore Home, New York City Litchfield County Hospital, Winsted, Conn. *President*, 1894; *Vice-President*, 1887; *Member of Council*, 1889.

1910. DOWD, CHARLES N., A.M., M.D., 127 West Seventy-second Street, New York, N. Y. Professor of Clinical Surgery, Columbia University; Attending Surgeon, Roosevelt Hospital; Consulting Surgeon, Memorial Hospital, and St. Mary's Free Hospital for Children, New York.

1914. DOWNES, WILLIAM A., M.D., 424 Park Avenue, New York, N. Y. Assistant Professor of Clinical Surgery, Columbia University, College of Physicians and Surgeons; Attending Surgeon, St. Luke's, Memorial and Babies' Hospitals; Consulting Surgeon, Manhattan State Hospital, Hospital for Ruptured and Crippled, Infirmary for Women and Children, New York, United Hospital, Port Chester, N. Y.

1919. EASTMAN, JOSEPH RILUS, A.M., B.Sc., M.D., F.A.C.S., 331 N. Delaware St., Indianapolis, Ind. Professor of Surgery, Indiana University School of Medicine; Visiting Surgeon to City Hospital.

1901. ELIOT, ELLSWORTH, JR., M.D., 34 East Sixty-seventh Street, New York. Surgeon to the Presbyterian Hospital.

†1893. ELLIOT, JOHN WHEELOCK, A.M., M.D. (Harvard), 124 Beacon Street, Boston. Surgeon to Massachusetts General Hospital, 1893–1907; Clinical Instructor in Gynecology, 1888–9, and Lecturer on Surgery, 1900–5, Harvard Medical School; Chairman, N. E. Surgical Dressings Committee, 1917.

1911. ELTING, ARTHUR W., A.B., M.D., LL.D., 119 Washington Avenue, Albany, N. Y. Professor of Surgery in the Albany Medical College; Surgeon to the Albany Hospital, and Surgeon to the Child's Hospital, Albany, N. Y.

†1896. ESTES, WILLIAM LAWRENCE, A.M., M.D., South Bethlehem, Pa. Director and Surgeon-in-Chief of St. Luke's Hospital, Lecturer on Hygiene at Lehigh University.

1898. EVE, DUNCAN, A.M., M.D., Eve Building, Nashville, Tenn. Professor of Surgery and Clinical Surgery, Medical Department, Vanderbilt University; Chief Surgeon of the N. C. & St. Louis Railway; Consulting Surgeon to Nashville City, St. Thomas and Woman's Hospitals.

ELECTED

1899. FINNEY, JOHN M. T., M.D., 1300 Eutaw Place, Baltimore, Md. Associate Professor of Surgery, Johns Hopkins University.

1915. FLINT, JOSEPH MARSHALL, B.S., M.A., M.D., 320 Temple Street, New Haven, Conn. Professor of Surgery at Yale University.

1904. FRAZIER, CHARLES HARRISON, M.D., 1724 Spruce Street, Philadelphia, Pa. Professor of Clinical Surgery, University of Pennsylvania; Surgeon to the University Hospital.

1898. FREEMAN, LEONARD, B.S., M.D., 424 Metropolitan Building, Denver, Col. Professor of Surgery, Medical Department, University of Colorado; Surgeon to Denver City and County, St. Joseph's, and National Jewish Hospitals; Consulting Surgeon, Children's and Mercy Hospitals, Denver, Col. *Vice-President*, 1908.

1910. GAGE, HOMER, A.M., M.D., 72 Pearl Street, Worcester, Mass. Surgeon-in-Chief to Memorial Hospital; Consulting Surgeon to Worcester City and St. Vincent's Hospitals.

1919. GAUB, OTTO CARL, M.D., F.A.C.S. Hotel Schenley, Pittsburgh, Pa. Surgeon to Allegheny General Hospital and to Columbia Hospital.

†1882. GAY, GEORGE WASHINGTON, A.M., M.D., 665 Boylston Street, Boston, Mass. Senior Surgeon to the Boston City Hospital. *Member of Council*, 1882.

†1892. GERRISH, FREDERIC HENRY, A.M., M.D. (Bowdoin), LL.D. (University of Michigan and Bowdoin), 675 Congress Street, Portland, Maine. Professor Emeritus of Surgery in the Bowdoin Medical School; Consulting Surgeon to the Maine General Hospital.

1890. GERSTER, ARPAD G., M.D., Chir.D., 34 East Seventy-fifth Street, New York. Emeritus Professor of Surgery in the New York Polyclinic, former Professor of Clinical Surgery, Columbia University; Consulting Surgeon to Lenox Hill and Mount Sinai Hospitals.

1906. GIBBON, JOHN H., M.D., *Secretary*, 1608 Spruce Street, Philadelphia. Professor of Surgery, Jefferson Medical College and Surgeon to the Jefferson College Hospital; Surgeon to the Pennsylvania Hospital and Consulting Surgeon to the Bryn Mawr Hospital.

1906. GIBSON, C. L., M.D., 72 East Fifty-fourth Street, New York, N. Y. Professor of Surgery, Cornell University Medical College; Attending Surgeon to the First Surgical (Cornell Medical) Division of the New York Hospital; Consulting

ELECTED

Surgeon to St. Luke's, City, and General Memorial Hospitals. *Vice-President*, 1915.

1911. GREENOUGH, ROBERT B., A.B. (Harvard), M.D. (Harvard), 8 Marlborough Street, Boston, Mass. Assistant Professor of Surgery, Harvard Medical School; Visiting Surgeon, Massachusetts General Hospital.

1916. HAGGARD, WILLIAM D., M.D., F.A.C.S., 706 Church Street, Nashville, Tenn. Professor of Surgery, Vanderbilt University; Surgeon to St. Thomas' Hospital.

1909. HALSTEAD, ALBERT E., M.D., 30 N. Michigan Avenue, Chicago, Ill. Professor of Surgery, School of Medicine, University of Illinois; Attending Surgeon to the St. Luke's and Cook County Hospitals; Consulting Surgeon to the Illinois Charitable Eye and Ear Infirmary; Lieut.-Col., M.C., U.S.A.

†1892. HALSTED, WILLIAM STEWART, A.B. (Yale University, 1874), M.D. (Columbia University, College of Physicians and Surgeons, N. Y., 1877), LL.D. (Yale University, 1904, and University of Edinburgh, 1905), Sc.D. (Columbia University, 1904), 1201 Eutaw Place, Baltimore, Md. Foreign Corresponding Member, Harveian Society, London; Honorary Fellow, Royal College of Surgeons, England, 1900; Edinburgh, 1905 and College of Surgeons of America, 1913; Membre corresp. étranger de la société de chirurgie, Paris, 1909; Membre titulaire de l'association française de chirurgie, 1914; Ehrenmitglied der deutschen Gesellschaft für Chirurgie, 1914; Hon. Member Societas medicorum Sverana, Stockholm, 1918; Foreign member Royal Swedish Academy of Science, 1918; Member of the National Academy of Sciences; Surgeon-in-Chief, the Johns Hopkins Hospital; Professor of Surgery and Director of the Surgical Clinic of the Johns Hopkins University.

1909. HAMANN, CARL A., M.D., 416 Osborn Bldg., Cleveland, Ohio. Professor of Applied Anatomy, Western Reserve University; Visiting Surgeon to Charity and City Hospitals.

1900. HARRIS, MALCOLM L., M.D., 25 E. Washington St., Chicago, Ill. Professor of Surgery, Chicago Policlinic; Attending Surgeon, Alexian Brothers' Hospital, Henrotin Hospital, Passavant Hospital; Consulting Surgeon to Maurice Porter Hospital for Children.

ELECTED

1895. HARTE, RICHARD H., M.D., C.M.G., 1503 Spruce Street, Philadelphia. Emeritus Surgeon to the Pennsylvania Hospital and Consulting Surgeon to St. Mary's, St. Timothy's, Abington, and Bryn Mawr Hospitals; Colonel M.R.C., U.S.A; formerly Director Base Hospital No. 10, U.S.A., and later O. C. No. 16, General Hospital, B.E.F. *President*, 1910.

1916. HARTWELL, JOHN A., Ph.B., M.D., 27 East Sixty-third Street, New York. Associate Professor of Surgery and Professor of Clinical Surgery, Cornell University Medical College; Director of Surgery, Cornell University Division, Bellevue Hospital; Consulting Surgeon to Lincoln Hospital, Lawrence Hospital, Bronxville, N. Y., and United Hospital, Port Chester, N. Y.

1918. HODGE, EDWARD BLANCHARD, A.B., M.D., 346 South 16th St., Philadelphia, Pa. Surgeon to Presbyterian and Children's Hospitals; Out-patient Surgeon to Pennsylvania Hospital; Associate Surgeon to Widener Memorial School.

1909. HOTCHKISS, LUCIUS WALES, A.B., M.D., 11 East Forty-eighth Street, New York. Professor of Clinical Surgery, Columbia University; Consulting Surgeon to Bellevue, Knickerbocker, Flushing and Greenwich Hospitals; Junior Surgeon to Roosevelt Hospital, New York City.

1918. HUBBARD, JOSHUA C., M.D., 86 Bay State Road, Boston, Mass. Visiting Surgeon, Boston City Hospital; Surgeon, Newton Hospital; Consulting Surgeon, Norwood Hospital and Leonard Morse Hospital.

†1901. HUNTINGTON, THOMAS W., A.B., M.D., LL.D., 960 Mills Building, San Francisco, California. Professor of Clinical and Operative Surgery (Emeritus), College of Medicine, University of California; Consulting Surgeon, St. Luke's Hospital, San Francisco; Chief Surgeon, Western Pac. R. R. *Vice-President*, 1906; *President*, 1917.

1919. HUPP, FRANK LE MOYNE, A.M., M.D., 61 Fourteenth St., Wheeling, W. Va. Attending Surgeon, Ohio Valley General Hospital; Consulting Surgeon, Reynolds Memorial Hospital, Glendale; Sheltering Arms Hospital, Hansford.

1913. HUTCHISON, JAMES ALEXANDER, M.D., L.R.C.P. and S. (Edin.), 354 MacKay Street, Montreal. Professor of Surgery and Clinical Surgery, McGill University; Attending Surgeon, Montreal General Hospital.

ELECTED

1909. HUTCHINSON, JAMES P., M.D., 133 South Twenty-second Street, Philadelphia. Surgeon to the Pennsylvania, Methodist, Children's, St. Timothy's and Bryn Mawr Hospitals.

1913. JACKSON, JABEZ N., A.M., M.D., 425 Argyle Building, Kansas City, Mo. Surgeon and Chief of Staff of Christian Church Hospital; Surgeon, Kansas City General Hospital.

1905. JOHNSON, ROBERT W., A.B., M.D., 101 W. Franklin Street, Baltimore, Md. Professor of Principles and Practice of Surgery, Baltimore Medical College; Surgeon to Maryland General Hospital, Church Home and Infirmary, and St. Agnes' Hospital. Retired.

1901. JONAS, A. F., M.D., 512 McCayne Bldg., Omaha, Nebraska. Professor of Surgery, Omaha Medical College; Surgeon to the Methodist Episcopal Hospital and to the Douglas County Hospital; Captain, M.C. *Vice-President*, 1906.

1917. JONES, DANIEL FISKE, A.B., M.D., 195 Beacon Street, Boston. Mass. Visiting Surgeon, Massachusetts General Hospital; Consulting Surgeon to the New England Hospital for Women and Children, Brockton City Hospital, Union Hospital of Fall River, Sturdy Hospital of Attleboro and the Addison Gilbert Hospital of Gloucester, Mass.

1910. JOPSON, JOHN HOWARD, M.D., *Recorder*, 1824 Pine Street, Philadelphia, Pa. Professor of Surgery, the Graduate School of Medicine, University of Pennsylvania; Associate in Surgery, University of Pennsylvania; Surgeon to Presbyterian Hospital, Children's Hospital and Bryn Mawr Hospital.

1914. JUDD, EDWARD STARR, M.D., Rochester, Minn., Surgeon to Mayo Clinic.

1899. KAMMERER, FREDERIC, M.D., 51 East Sixty-sixth Street, New York City. Professor of Clinical Surgery, Columbia University; Attending Surgeon to the Lenox Hill Hospital; Consulting Surgeon to St. Francis Hospital, New York.

1913. KANAVEL, ALLEN B., A.B., M.D., 30 North Michigan Avenue, Chicago, Ill. Professor of Surgery, Northwestern University Medical School; Attending Surgeon to Wesley Memorial and Cook County Hospitals.

*†1880. KEEN, WILLIAM WILLIAMS, A.M., M.D., LL.D., Hon. F.R.C.S. (Eng. and Edin.), Hon. F.A.C.S., 1729 Chestnut

ELECTED

Street, Philadelphia. Emeritus Professor of Surgery in the Jefferson Medical College; Consulting Surgeon to the Jefferson Medical College Hospital and to the Woman's and St. Agnes' Hospitals; Membre Correspondant Etranger de la Société de Chirurgie de Paris; Membre Honoraire de la Société Belge de Chirurgie; Honorary Member, Clinical Society of London, etc. *President*, 1898; *Vice-President*, 1892; *Member of Council*, 1899–1901.

1916. LAW, ARTHUR AYER, M.D., F.A.C.S., 420 Syndicate Building, Minneapolis, Minn. Associate Professor of Surgery, University of Minnesota Medical School, and Mayo Foundation; Surgeon to the Northwestern Hospital; Surgeon to and Assistant Chief of the University Hospital; Lieut.-Col., M.C. (discharged), Commanding University of Minnesota Base Hospital No. 26 in A.E.F.

1901. LE CONTE, ROBERT G., A.B., M.D., 2000 Spruce Street, Philadelphia. Surgeon to the Pennsylvania Hospital; Consulting Surgeon to the Germantown, the Bryn Mawr and the Gynecean Hospitals. *President*, 1915.

1919. LEE, BURTON JAMES, PH.B., M.D., F.R.C.S., 128 East 73d Street, New York. Clinical Professor of Surgery, Cornell Medical School; Associate Attending Surgeon, New York Hospital; Consulting Surgeon, Sharon (Connecticut) Hospital.

1912. LEWIS, DEAN D., M.D., 122 S. Michigan Ave., Chicago, Ill. Professor of Surgery, Rush Medical College; Attending Surgeon to the Presbyterian Hospital, Chicago; Consulting Surgeon to the Annie Durand Hospital for Contagious Diseases.

1910. LILIENTHAL, HOWARD, A.B., M.D., 52 East Eighty-second Street, New York. Attending Surgeon, Mount Sinai Hospital; Visiting Surgeon to Bellevue Hospital; Consulting Surgeon, Hospital for Joint Diseases, Jewish Maternity Hospital and Har Moriah Hospital; Professor of Clinical Surgery, Cornell Medical College; formerly Lieut.-Col., M.C., U.S.A.

1908. LOTHROP, HOWARD AUGUSTUS, A.M., M.D., 101 Beacon Street, Boston, Mass. Assistant Professor of Surgery, Harvard Medical School; Surgeon-in-Chief, Boston City Hospital.

ELECTED

1916. LOWER, WILLIAM E., M.D., 1021 Prospect Avenue, Cleveland, Ohio. Associate Professor of Genito-urinary Surgery, School of Medicine, Western Reserve University; Director of Surgery, Mount Sinai Hospital; Associate Surgeon in charge of Genito-urinary Surgery, Lakeside Hospital; Visiting Surgeon, Lutheran Hospital and White Hospital (Ravenna).

1910. LUND, FREDERICK BATES, M.D., 527 Beacon Street, Boston, Mass. Associate in Surgery, Harvard Medical School; Surgeon-in-Chief, Boston City Hospital; Consulting Surgeon, Burbank Hospital, Fitchberg, Newton Hospital, Newton; lately Lieut.-Col., M.C., U.S.A.

1917. LYLE, HENRY H. M., M.D., 117 East Fifty-sixth Street, New York City. Professor of Clinical Surgery, College of Physicians and Surgeons, Columbia University; Attending Surgeon, St. Luke's Hospital.

1901. MCARTHUR, L. L., M.D., 122 S. Michigan Boulevard, Chicago, Ill. Professor of Clinical Surgery, Post-Graduate Medical School; Assistant Professor of Clinical Surgery, Rush Medical, College; Senior Surgeon to St. Luke's and Michael Reese Hospitals.

1882. MCGRAW, THEODORE A., M.D., 73 Case Street, Detroit, Mich. Professor of Surgery in the Detroit Medical College; Surgeon to St. Mary's and Harper Hospitals. *Vice-President*, 1896.

1917. MCGUIRE, STUART, M.D., LL.D., 513 East Grace Street, Richmond, Va. Professor of Surgery, Medical College of Virginia; Surgeon in Charge of St. Luke's Hospital; Visiting Surgeon to Memorial Hospital.

1903. MCMURTRY, LEWIS S., A.M., M.D., LL.D., 542 Atherton Building, Louisville, Ky. Professor of Gynecology and Abdominal Surgery in the Medical Department, University of Louisville; Surgeon to the Louisville City Hospital.

1915. MCRAE, FLOYD W., M.D., Peters Building, Atlanta, Ga. Chief Surgeon to the Piedmont Sanatorium; Visiting Surgeon to St. Joseph's Infirmary; Consulting Surgeon to Grady Hospital.

1918. MCWILLIAMS, CLARENCE A., M.A., M.D., 19 East Sixty-fifth Street, New York, N. Y. Associate Surgeon, Presbyterian Hospital, Instructor in Surgery, Columbia University.

1908. MACKENZIE, KENNETH A. J., M.D., F.A.C.S., L.R.C.P., L.R.C.S. (Edin.), 908–910 Corbett Bldg., Portland, Oregon.

ELECTED

Dean of the Medical School, University of Oregon, and Head of the Department of Surgery; Surgeon to St. Vincent's Hospital, Portland, Oregon.

1904. MacLaren, Archibald, M.D., B.S., 914 Lowry Building, St. Paul, Minn. Professor of Clinical Surgery, University of Minnesota. *Vice-President*, 1915.

1914. MacLaren, Murray, B.A., M.B.C.M., M.D., M.R.C.S. (Eng.), C.M.G. (Order of Avis), LL.D., 75 Coburg Street, St. John's, N.B., Canada. Surgeon to the General Public Hospital; Colonel, C.A.M.C.

1898. Martin, Edward, A.M., M.D., LL.D., 135 S. 18th Street, Philadelphia. Commissioner of Health of Pennsylvania; Professor of Surgical Physiology, University of Pennsylvania; Consulting Surgeon to State Hospitals, Norristown and Wernersville, Pa.; Colonel, M.R.C., U.S.A.

1915. Martin, Walton, Ph.B., M.D., 151 East Sixty-third Street, New York. Professor of Clinical Surgery, Columbia University; Attending Surgeon, St. Luke's Hospital; Consulting Surgeon, White Plains Hospital and Loomis Sanatorium.

†1895. Mastin, William McDowell, M.D., LL.D., Northeast corner of Joachim and Conti Streets, Mobile, Ala. Surgeon to the Mobile City Hospital and Providence Infirmary.

1895. Matas, Rudolph, M.D., LL.D., 2255 St. Charles Avenue, New Orleans, Louisiana. Professor of Surgery, Tulane University of Louisiana, School of Medicine; Professor (Emeritus), Graduate Medical School, Tulane University; Senior, Surgical Division, Touro Infirmary; Chief of Surgical Service, Visiting Staff, Charity Hospital; Consulting Surgeon, Eye, Ear, Nose and Throat Hospital; Major, Reserve Corps, U. S. Army. *President*, 1909; *Vice-President*, 1901.

1918. Mathews, Francis Stuart, B.S., M.D., F.A.C.S., 62 West Fiftieth Street, New York. Professor of Clinical Surgery, Columbia University; Surgeon to St. Luke's Hospital and St. Mary's Hospital for Children.

1903. Mayo, Charles H., A.M., M.D., LL.D., D.Sc., F.A.C.S., Rochester, Minn. Professor of Surgery, Medical School, University of Minnesota; Surgeon to Mayo Clinic (St. Mary's Hospital).

1899. Mayo, William J., A.M., M.D. (Mich.), D.Sc. (Columbia and Mich.), F.R.C.S. (Eng. and Edin.), LL.D. (Tor., Md. and Penna.), C.E., Soc. de Chir. de Paris, F.A.C.S., 701

ELECTED

College Hill, Rochester, Minn. Surgeon to St. Mary's Hospital. *Vice-President*, 1903; *President*, 1915.

1901. MEYER, WILLY, M.D., 700 Madison Avenue, New York. Professor of Surgery in the New York Post-Graduate Medical School and Hospital; Attending Surgeon to the Lenox Hill Hospital; Consulting Surgeon to the New York Infirmary for Women and Children, New York Skin and Cancer Hospital, Hospital for Deformities and Joint Diseases and the Montefiore Hospital.

1919. MILLER, ROBERT TALBOTT, A.B., M.D., 1226 Murray Hill Avenue, Pittsburgh, Pa. Professor of Surgery, University of Pittsburgh; Surgeon to Mercy Hospital.

1917. MITCHELL, CHARLES F., M.D., 332 South Fifteenth Street, Philadelphia, Pa. Attending Surgeon to the Germantown, Bryn Mawr and Pennsylvania Hospitals.

1912. MITCHELL, JAMES F., A.B., M.D., 1344 Nineteenth Street, Washington, D. C. Clinical Professor of Surgery, Georgetown and George Washington Universities; Chief Surgeon, Emergency Hospital.

†1893. MIXTER, SAMUEL JASON, S.B. (Massachusetts Institute of Technology), M.D. (Harvard), 180 Marlborough Street, Boston. Consulting Surgeon to Massachusetts General Hospital and to Massachusetts Charity Eye and Ear Infirmary. *President*, 1916.

†1896. MONKS, GEORGE HOWARD, A.B. (Harvard), M.D. (Harvard), M.R.C.S. (Eng.), 51 Commonwealth Ave., Boston. Consulting Surgeon, Boston City Hospital; Professor of Oral Surgery, Harvard Dental School.

1914. MOSCHCOWITZ, ALEXIS V., M.D., 925 Madison Ave., New York, N. Y. Professor of Clinical Surgery, College of Physicians and Surgeons, Columbia University; Attending Surgeon, Mount Sinai Hospital.

1904. MUDD, HARVEY G., M.D., Humboldt Bldg., St. Louis, Mo. Clinical Professor of Surgery, Medical Department, Washington University; Surgeon to St. Luke's Hospital; Consulting Surgeon to the Barnard Free Skin and Cancer Hospital.

1919. MÜLLER, GEORGE P., M.D., 1930 Spruce St., Philadelphia, Pa. Professor of Surgery, Graduate School of the University of Pennsylvania; Associate in Surgery, Medical School of the University of Pennsylvania; Surgeon to the Misericordia and St. Agnes Hospitals; Consulting Surgeon to the Chester County Hospital, West Chester, Pa.

ELECTED

1913. MURPHY, FRED T., A.B., M.A., M.D., 2248 Penobscot Bldg., Detroit, Michigan.

†1898. MURRAY, FRANCIS W., M.D., 32 West Thirty-ninth Street, New York City. Consulting Surgeon, New York Hospital, St. Luke's Hospital, New York Eye and Ear Infirmary, Paul Kimball Hospital, Lakewood, Goshen Emergency Hospital.

†1882. DE NANCRÈDE, C. B. G., A.M. (University of Pennsylvania), A.M. (University of Michigan), M.D. (University of Pennsylvania and Jefferson Medical College), LL.D. (Jefferson and University of Michigan), 900 Forest Avenue, Ann Arbor, Michigan. Professor of Surgery in the University of Michigan; Professor of Surgery, Dartmouth Medical College. *President*, 1908; *Vice-President*, 1889 and 1899.

1903. NEILSON, THOMAS R., M.D., 1937 Chestnut Street, Philadelphia, Pa. Surgeon to the Episcopal Hospital and to St. Christopher's Hospital for Children; Clinical Professor of Genito-urinary Diseases in the University of Pennsylvania.

1915. NICHOLS, EDWARD HALL, A.B., A.M., M.D., 294 Marlborough Street, Boston, Massachusetts. Clinical Professor of Surgery, Harvard University Medical School; Senior Visiting Surgeon, Boston City Hospital; Consulting Surgeon, City Hospital, Quincy, and Framingham Hospital, Framingham.

1900. OCHSNER, A.J., B.S., F.R.M.S., M.D. (Eng.), LL.D.; F.A.C.S., 710 Sedgwick Street, Chicago. Professor of Clinical Surgery, College of Physicians and Surgeons; Surgeon-in Chief of Augustana and St. Mary's Hospitals.

1900. OLIVER, J. C., M.D., 628 Elm Street, Cincinnati, Ohio. Acting Dean and Professor of Surgery, Medical Department, University of Cincinnati; Director of Second Surgical Service, Cincinnati General Hospital; Surgeon to the Christ Hospital.

1915. OLMSTED, INGERSOLL, M.B., 215 James Street, South, Hamilton, Ontario. Surgeon to City Hospital.

†1882. OWENS, JOHN E., M.D., 1017–18 Venetian Building, Chicago, Ill. Professor of Principles and Practice of Surgery and Clinical Surgery in the Chicago Medical College; Surgeon to St. Luke's Hospital. *Vice-President*, 1900.

ELECTED

1899. PARHAM, FREDERICK WILLIAM, M.D., 3513 Prytania Street, New Orleans, La. Professor of General Clinical Surgery, New Orleans Polyclinic (Post-Graduate Department of Tulane University of Louisiana); Chief of Staff to Charity Hospital and to Touro Infirmary.

†1893. PARMENTER, JOHN, M.D., 519 Franklin Street, Buffalo, N. Y. Late Professor of Clinical Surgery, Medical Department, University of Buffalo.

1908. PECK, CHARLES HOWARD, *Treasurer*, M.D., 30 W. Fiftieth St., New York City. Professor of Clinical Surgery, Columbia University; Senior Attending Surgeon to the Roosevelt Hospital; Consulting Surgeon to French Hospital, Memorial Hospital and Hospital for Ruptured and Crippled, New York City; Vassar Brothers Hospital, Poughkeepsie, N. Y.; Nyack Hospital, Nyack, N. Y.; White Plains Hospital, White Plains, N. Y.; United Hospital, Portchester and Rye, N. Y.; Stamford Hospital, Stamford, Conn.; Greenwich Hospital, Greenwich, Conn.; Hackensack Hospital, Hackensack, N. J.

1919. PERCY, NELSON MORTIMER, M.D., F.A.C.S., 2106 Sedgwick Street, Chicago, Ill. Associate Professor of Clinical Surgery, Medical Department of the University of Illinois; Attending Surgeon to the Augustana and St. Mary's of Nazareth Hospitals.

1917. PHEMISTER, DALLAS B., B.S., M.D., 122 South Michigan Ave., Chicago, Ill. Assistant Professor in Surgery, Rush Medical College; Associate Attending Surgeon, Presbyterian Hospital.

†1889. PILCHER, LEWIS STEPHEN, A.M., M.D., LL.D. (Dickinson and University of Michigan), 145 Gates Avenue, Brooklyn, N. Y. Consulting Surgeon to the St. John, Norwegian, Jewish, Bushwick and Deaconess Hospitals. *Vice-President*, 1893, 1914. *President*, 1918.

1914. PLUMMER, SAMUEL C., A.B., M.D., 4539 Oakenwald Avenue, Chicago, Ill. Attending Surgeon, St. Luke's Hospital; Chief Surgeon, C. R. I. & P. Ry. Co.

1914. POOL, EUGENE HILLHOUSE, A.B., M.D., 107 East Sixtieth Street, New York, N. Y. Attending Surgeon, New York Hospital; Associate Professor of Surgery, Columbia University; Consultant Surgeon to French Hospital, New York Orthopedic, Manhattan State Hospital, Home for Incurables and United Hospital at Portchester.

ELECTED

1904. PORTER, CHARLES ALLEN, A.M., M.D., 116 Beacon Street, Boston, Mass. Chief of West Surgical Service, Massachusetts General Hospital; Professor of Clinical Surgery, Harvard Medical School.

1915. PORTER, MILES FULLER, M.A., M.D., Walnut Place, Fort Wayne, Ind. Professor of Surgery in the Indiana University School of Medicine; Surgeon to St. Joseph's Hospital; Consulting Surgeon in the Indiana School for Feeble-minded Youths.

†1896. POWERS, CHARLES A., A.M., M.D., University Club, Denver, Col. Professor of Surgery, Emeritus, in the University of Colorado; Consulting Surgeon to the Denver City and County Hospital, to the Mercy Hospital, and to the State Home for Children. *President*, 1912; *Vice-President*, 1903; *Treasurer*, 1906–1912; *Member of Council*, 1906–1916.

1908. PRIMROSE, ALEXANDER, C.B., M.B., C.M. (Edin.), M.R.C.S. (Eng.), 100 College Street, Toronto, Canada. Surgeon to the Toronto General Hospital and Consulting Surgeon to the Hospital for Sick Children, Toronto; Professor of Clinical Surgery in the University of Toronto.

†1886. RANSOHOFF, JOSEPH, M.D., F.A.C.S., F.R.C.S. (Eng.), Livingston Bldg., 707 Race Street, Cincinnati, Ohio. Professor of Surgery, University of Cincinnati; Director, First Surgical Service, Cincinnati General Hospital; Dean, Jewish Hospital. *Vice-President*, 1911.

1901. RIXFORD, EMMET, B.S., M.D., 1795 California Street, San Francisco, Cal. Professor of Surgery in Stanford University School of Medicine; Surgeon to the San Francisco and Lane Hospitals; Member of the Society of Clinical Surgery. *Vice-President*, 1905.

†1882. ROBERTS, JOHN B., A.M., M.D., 313 South Seventeenth Street, Philadelphia. Professor of Surgery in the University of Pennsylvania Graduate School of Medicine. *Vice-President*, 1888 and 1894; *Treasurer*, 1892–93.

1914. ROSS, GEORGE GORGAS, M.D., 1721 Spruce Street, Philadelphia, Pa. Visiting Surgeon, Germantown Hospital; Assistant Surgeon, Lankenau Hospital; Visiting Surgeon to the Stetson and Methodist Hospitals; Assistant Surgeon to the University Hospital; Associate in Surgery, University of Pennsylvania.

ELECTED

1917. ROWAN, CHARLES J., A.B., M.D., Iowa City, Iowa. Professor and Head of Department of Surgery, College of Medicine, State University of Iowa; Director of the University Hospital.

†1882. RUSHMORE, JOHN DIKEMAN, M.D., 129 Montague Street, Brooklyn, N. Y. Professor of Operative and Clinical Surgery, Emeritus, Long Island College Hospital; Surgeon to St. Peter's Hospital; Consulting Surgeon to Long Island College Hospital, Kings County Hospital, Swedish and Lutheran Hospitals.

1909. SCUDDER, CHARLES L., M.D., A.B., Ph.B., 209 Beacon Street, Boston, Mass. Assistant Professor of Surgery, Harvard Medical School; Chief of the East Surgical Service, Massachusetts General Hospital; Member of the Administrative Board of the Graduate School of Medicine, Harvard University.

1919. SEELIG, M. G., A.B., M.D., 4952 Park View Place, St. Louis, Mo. Professor of Surgery, St. Louis University; Visiting Surgeon to the Jewish Hospital and to the St. Louis City Hospital.

†1902. SHEPHERD, FRANCIS J., M.D., LL.D., F.R.C.S. (Eng.), 152 Mansfield Street, Montreal, Canada. Emeritus Professor in McGill University; Consulting Surgeon to the Montreal General Hospital and Royal Victoria Hospital, Montreal.

1905. SHERMAN, HARRY M., A.M., M.D., 350 Post Street, San Francisco, Cal. Surgeon to St. Luke's Hospital, San Francisco; Orthopedic Surgeon to the Children's Hospital, San Francisco.

1918. SMITH, REA, M.D., 22 Chester Place, Los Angeles, Cal. Surgeon, California Hospital and Los Angeles County Hospital.

†1895. SOUCHON, EDMOND, M.D., 2403 St. Charles Avenue, New Orleans, La. Professor of Anatomy and of Clinical Surgery, Tulane University; Surgeon to Charity Hospital; Consulting Surgeon to the Eye, Ear, Nose, and Throat Hospital. Honorary Fellow of American College of Surgeons; Former President of Louisiana State Board of Health, 1898–1905. *Vice-President*, 1899.

1919. SPEED, KELLOGG, S.B., M.D., F.A.C.S., 122 South Michigan Avenue, Chicago, Ill. Assistant Professor of Surgery, Rush Medical College, Attending Surgeon, Cook County

ELECTED

and Provident Hospitals; Assistant Surgeon, Presbyterian Hospital; Consulting Surgeon, U. S. P. H. S. Hospital No. 2.

1918. STARR, CLARENCE LESLIE, M.B., M.D., 224 Bloor St., West, Toronto, Canada. Associate Professor of Surgery, University of Toronto; Surgeon-in-Chief, Hospital for Sick Children; Consultant in Surgery, Toronto General Hospital; Surgeon to St. John's Hospital; Lieut.-Col.-Consultant, C. A. M. C.

1914. STARR, FREDERIC NEWTON GISBORNE, C.B.E., M.B., M.D., C.M., 112 College Street, Toronto, Canada. Associate Professor of Clinical Surgery, University of Toronto; Surgeon to Hospital for Sick Children, and to St. John's Hospital for Women; Senior Assistant Surgeon, Toronto General Hospital.

‡1911. STEWART, FRANCIS T., M.D., 311 S. 12th Street, Philadelphia, Pa. Professor of Clinical Surgery, Jefferson Medical College; Surgeon to the Pennsylvania Hospital.

1915. STEWART, GEORGE DAVID, M.D., 61 West Fiftieth Street, New York. President, New York Academy of Medicine; Professor of Surgery, New York University Medical School; Visiting Surgeon to St. Vincent's and Bellevue Hospitals; Consulting Surgeon to Hospital for Ruptured and Crippled of New York, to St. Joseph's Hospital, Yonkers, to St. Mary's Hospital, East Orange, N. J., to South Side Hospital, Babylon, L. I., to Englewood Hospital, Englewood, N. J., and to the United Hospital, Portchester, N. Y.

1909. STILLMAN, STANLEY, M.D., 2101 Webster Street, San Francisco, Cal. Professor of Surgery, Stanford University Medical School; Commander, M. C., U. S. N. R. F.; Surgeon to Lane and Stanford University Hospitals.

1912. STOKES, CHARLES F., A.M., M.D., D.Sc., LL.D., 6 West 77th Street, New York City. Former Surgeon-General, U. S. N.

1909. SUMMERS, JOHN EDWARD, M.D., 618 Brandeis Theatre Bldg., Omaha, Neb. Professor of Clinical Surgery, University of Nebraska Medical School; Surgeon to the University Hospital and to the Clarkson Memorial, the Wise Memorial, and the Douglas County Hospitals, Omaha, Neb.

1900. TAYLOR, WILLIAM J., M.D., 1825 Pine Street, Philadelphia. Surgeon to the Orthopædic Hospital and Infirmary for Nervous Diseases, and to St. Agnes' Hospital; Consulting Surgeon to the West Philadelphia Hospital for Women and to the Woman's Hospital.

ELECTED

1916. Terry, Wallace I., B.S., M.D., 240 Stockton Street, San Francisco, Cal. Professor of Surgery, University of California; Chief Surgeon, University of California Hospital, San Francisco.

1909. Thompson, James E., M.B., B.S. (London), F.R.C.S. (Eng.), F.A.C.S., 3224 Broadway, Galveston, Texas. Professor of Surgery in the University of Texas; Surgeon to the John Sealy Hospital.

1918. Truesdale, Philemon Edwards, M.D., 177 Winter St., Fall River, Mass. Surgeon to St. Anne's and Highland Hospitals; Consulting Surgeon to Fall River City Hospital.

†1882. Vander Veer, Albert, A.M., M.D., Ph.D., LL.D., 28 Eagle Street, Albany, N. Y. Surgeon-in-Chief, Albany Hospital; Consulting Surgeon, Albany Free Dispensary Association, Benedictine Hospital, Kingston, N. Y., and Champlain Valley Hospital, Plattsburgh, N. Y. *President*, 1905; *Vice-President*, 1898; *Member of Council*, 1907.

1910. Vander Veer, Edgar Albert, Ph.B., M.D., 28 Eagle Street, Albany, N. Y. Attending Surgeon, Albany Hospital; Consulting Surgeon, Champlain Valley Hospital and Benedictine Hospital, Kingston, N. Y.

1902. Vaughan, George Tully, M.D., LL.D., 1718 I Street, Washington, D. C. Professor of Principles and Practice of Surgery and Head of the Surgical Department, Georgetown University; Chief Surgeon, Georgetown University Hospital; Surgeon, Tuberculosis Hospital; Consulting Surgeon, Government Hospital for the Insane, Washington, D. C., U. S. Public Health Service and Washington Asylum Hospital; Commander, M. C., Reserve Force, U. S. N.

1918. Wainwright, Jonathan M., A.B., A.M., M.D., 912 Clay Ave., Scranton, Pa. Surgeon-in-Chief, Moses Taylor Hospitals (Scranton and Buffalo); Chief Surgeon, D. L. & W. R. R. Co.

1891. Walker, Edward W., M.D., 30 Garfield Place, Cincinnati, Ohio. Professor of Surgery, Miami Medical College.

1909. Walker, John B., M.D., 51 East Fiftieth Street, New York City. Surgeon to Bellevue Hospital and Hospital for Ruptured and Crippled, New York; Professor of Clinical Surgery, College of Physicians and Surgeons, Columbia University, N. Y.

ELECTED

†1882. WARREN, JOHN COLLINS, M.D., LL.D. (Jefferson, Harvard and McGill), Hon. F.R.C.S. (Eng. and Edin.), 58 Beacon Street, Boston, Mass. Emeritus Professor of Surgery in Harvard University; Consulting Surgeon to the Massachusetts General Hospital. *President*, 1896; *Vice-President*, 1890; *Member of Council*, 1897.

†1896. WATSON, FRANCIS SEDGWICK, A.B., M.D., 92 Marlborough St., Boston. Surgeon to the Boston City Hospital; Instructor in Genito-Urinary Surgery, Harvard Medical School.

1913. WATTS, STEPHEN H., M.A., M.D., Department of Surgery, University of Virginia, Charlottesville, Va. Professor of Surgery and Gynecology in the University of Virginia; Surgeon-in-Chief, University of Virginia Hospital.

†1889. WEIR, ROBERT F., A.M., M.D., Hon. F.R.C.S. (Eng.), Cor. Mem. Surg. Soc., Paris, 1155 Park Avenue, New York. Professor of Surgery in the College of Physicians and Surgeons, Columbia University; Surgeon to the Roosevelt Hospital. *President*, 1899; *Member of Council*, 1893–1896; 1901–03.

†1892. WHARTON, HENRY R., A.M., M.D., 1725 Spruce Street, Philadelphia. Surgeon to the Presbyterian and Children's Hospitals.

1914. WINSLOW, RANDOLPH, A.B., M.D., A.M., LL.D., 1900 Mt. Royal Terrace, Baltimore, Md. Professor of Surgery, University of Maryland; Chief Surgeon, University Hospital; Consulting Surgeon, Hebrew Hospital, Baltimore, Union Hospital, Elkton, Md., and to James L. Kernan Hospital for Crippled Children, Baltimore.

1918. WOOD, ALFRED CONARD, M.D., 2035 Walnut St., Philadelphia, Pa. Assistant Professor of Surgery, University of Pennsylvania; Surgeon to the University, Philadelphia General, Howard, St. Timothy's and Rush Hospitals.

1901. WOOLSEY, GEORGE, M.D., 117 East Thirty-sixth Street, New York City. Professor of Clinical Surgery, Cornell University; Surgeon to Bellevue Hospital; Consulting Surgeon to Memorial, Peekskill and St. John's Riverside, Yonkers.

1916. YATES, J. L., Ph.B., B.S., M.D., F.A.C.S., 141 Wisconsin Street, Milwaukee, Wis. Chief of Staff, Milwaukee County Hospital; Attending Surgeon, Columbia Hospital.

SENIOR FELLOWS OF THE ASSOCIATION

Abbe, Robert, M.D., 13 West Fiftieth Street, New York.
Allis, Oscar H., A.M., M.D., 1604 Spruce Street, Philadelphia, Pa.

Barton, James M., A.M., M.D., 32 North New Hampshire Ave., Atlantic City, N. J.
Bradford, E. H., A.B., M.D., 133 Newbury Street, Boston, Mass.

Carmalt, William H., A.M., M.D., 261 St. Ronan St., New Haven, Conn.
Cole, Charles Knox, A.M., M.D., Helena, Montana.
Cushing, Hayward Warren, A.B., M.D., 70 Commonwealth Ave., Boston, Mass.

Dennis, Frederic Shepard, M.D., F.R.C.S. (Eng.), 62 East 55th Street, New York, N. Y.

Elliott, John Wheelock, A.M., M.D., 124 Beacon Street, Boston, Mass.
Estes, William Lawrence, A.M., M.D., South Bethlehem, Pa.

Gay, George W., A.M., M.D., 665 Boylston Street, Boston, Mass.
Gerrish, Frederic H., A.M., M.D., LL.D., 675 Congress Street, Portland, Me.
Gerster, Arpad G., M.D., Chir.D., 34 East Seventy-fifth Street, New York, N. Y.

Halsted, Wm. Stewart, A.B., LL.D., S.C.D., M.D., Hon. F.R.C.S. (Eng. and Edin.), Hon. F.A.C.S., 1201 Eutaw Place, Baltimore, Md.
Huntington, Thomas W., A.B., M.D., LL.D., 960 Mills Building, San Francisco, Cal.

Keen, W. W., A.M., M.D., LL.D., Hon. F.R.C.S. (Eng. and Edin.), Hon. F.A.C.S., 1729 Chestnut Street, Philadelphia, Pa.

Mastin, Wm. M., M.D., LL.D., Northeast corner Joachim and Conti Streets, Mobile, Ala.

Mixter, Samuel Jason, S.B., M.D., 180 Marlborough St., Boston, Mass.

Monks, George H., A.B., M.D., M.R.C.S., 51 Commonwealth Avenue, Boston, Mass.

Murray, Francis W., M.D., 32 West Thirty-ninth Street, New York, N. Y.

de Nancrède, C. B. G., A.M., M.D., LL.D., 900 Forest Avenue, Ann Arbor, Mich.

Owens, John E., M.D., 1201 Venetian Building, Chicago, Ill.

Parmenter, John, M.D., 519 Franklin Street, Buffalo, N. Y.

Pilcher, Lewis S., A.M., M.D., LL.D., 145 Gates Avenue, Brooklyn, New York. President, 1918.

Powers, Charles A., A.M., M.D., University Club, Denver, Colo.

Ransohoff, Joseph, M.D., F.R.C.S., F.A.C.S. (Eng.), 707 Race Street, Cincinnati, Ohio.

Roberts, John B., A.M., M.D., 313 South Seventeenth Street, Philadelphia, Pa.

Rushmore, John D., M.D., 129 Montague Street, Brooklyn, N. Y.

Shepherd, Francis J., M.D., LL.D., F.R.C.S. (Eng.), 152 Mansfield Street, Montreal, Canada.

Souchon, Edmund, M.D., 2403 St. Charles Ave., New Orleans, La.

Vander Veer, A., A.M., M.D., Ph.D., LL.D., 28 Eagle Street, Albany, N. Y.

Warren, J. Collins, M.D., LL.D., Hon. F.R.C.S. (Eng. and Edin.), 58 Beacon Street, Boston, Mass.

Watson, Francis S., A.B., M.D., 92 Marlborough Street, Boston, Mass.

Weir, Robert F., A.M., M.D., Hon. F.R.C.S. (Eng.), 1155 Park Avenue, New York, N. Y.

Wharton, Henry R., A.M., M.D., 1725 Spruce Street, Philadelphia, Pa.

HONORARY FELLOWS OF THE ASSOCIATION

ELECTED
ELECTED

1907. Ballance, Charles Alfred, K.C.M.G., C.B., M.V.O., M.B., M.S., University of London, F.R.C.S. (Eng.), 106 Harley Street, London. Consulting Surgeon to St. Thomas's Hospital and to the National Hospital for Paralysis and Epilepsy, Queen Sq.

1919. Bastianelli, Raffaelle, rue Delle Terne 83, Rome, Italy.

1919. Bowlby, Sir Anthony A., K.C.B., K.C.M.G., V.C.V.O., 25 Manchester Square W., London, England. Consulting Surgeon to St. Bartholomew's Hospital and to Queen Alexandra's Military Hospital.

1891. Chiene, John, F.R.C.S. (Edin.), M.D. (Edin.), Aithernie Davidsons Mains, Edinburgh. Emeritus Professor of Surgery, University of Edinburgh.

1916. Depage, Prof. Dr. Antoine, Le Panne, Belgium.

1916. Gorgas, William C., Surgeon-General, A.B., M.D., Sc.D., LL.D., War Department, Washington, D. C.

1919. Hartmann, Dr. Henri, 4 Place Malesherbes, Paris, France. Professor of Clinical Surgery, Faculté de Médecine de Paris and Surgeon to the Hotel Dieu.

1918. Keogh, Sir Alfred, Ky., K.C.B., Royal Army Medical Corps, England.

1894. Macewen, Sir William, M.D., M.B., M.S., 3 Woodside Crescent, Glasgow, Scotland. Professor of Surgery, The University, Glasgow.

1918. Makins, Sir George, Surgeon General, K.C.M.G., C.B., F.R.C.S., England.

1908. Moynihan, Sir B. G. A., M.S. (Lond.), F.R.C.S., 33 Park Square, Leeds, England. Surgeon to the Leeds Infirmary,

1907. Myles, Sir Thomas, M.D., F.R.C.S.I., 33 Merrion Square. N., Dublin, Ireland.

1903. Robson, A. W. Mayo, C.V.O., M.D., F.R.C.S., D.Sc., 8 Park Crescent, Portland Place, London, W., England. Vice-President, Royal College of Surgeons of England; Hunterian Professor of Surgery and Pathology.

1882. Smith, Stephen, A.M., M.D., LL.D., 574 Madison Avenue, New York. Professor of Clinical Surgery in the University Medical College of New York; Surgeon to the Bellevue and St. Vincent's Hospitals. *Vice-President*, 1890.

1912. Stiles, Harold Jalland, M.B., F.R.C.S. (Edin.), 9 Great Stuart Street, Edinburgh, Scotland. Surgeon to Chalmers Hospital and to the Royal Edinburgh Hospital for Sick Children, Edinburgh.

1914. Thomson, Alexis, B.M., M.S., M.D., (Edin.), M.R.C.S. (Eng.), 39 Drumsheugh Gardens, Edinburgh, Scotland. Professor of Surgery, University of Edinburgh.

1918. Tuffier, Th., M.D., 42 Avenue Gabriel, Paris, France.

DECEASED FELLOWS OF THE ASSOCIATION

Name	Date of death
Agnew, D. Hayes	March 22, 1892
Allen, Dudley Peter	January 6, 1915
Annandale, Thomas	1907
Ashhurst, John, Jr.	July 7, 1900
*Atlee, John Light	October 1, 1885
Beckman, Emil Hessel	November 7, 1916
Benham, Silas Nelson	November 3, 1890
*von Bergmann, Ernst	Died since 1906 Meeting
*Bigelow, Henry Jacob	October 30, 1890
*Billings, John Shaw	March 11, 1913
*Billroth, Albert Christian Theodor	January 5, 1894
Bontecou, R. B.	1906–1907
Briggs, William Thompson	June 13, 1894
Brinton, John Hill	March 18, 1908
Bristow, Algernon Thomas	March 26, 1913
Brock, Hugh W.	April 24, 1882
Bryant, Joseph Decatur	April 7, 1914
*Bryant, Thomas	1914–1915
Bull, William Tillinghast	February 22, 1909
Burrell, Herbert Leslie	1910
Byrd, William Andrew	August 14, 1887
Cabot, Arthur Tracy	November 4, 1912
Campbell, Henry Fraser	December 15, 1891
Cheever, David Williams	December 27, 1915
Conner, Phineas Sanborn	March 26, 1909
Cunningham, Francis Deane	September 11, 1885
*Czerny, Prof. Dr. Vincenz	October 3, 1916
Dandridge, Nathaniel P.	1911–1912
Davis, Gwilym G.	June 16, 1918
Davis, John Staige	July 18, 1885
Dawson, William Wirt	February 16, 1893
Dugas, Louis Alexander	October 19, 1884
Dunn, James Henry	June 16, 1904
Dunott, Thomas Justus	May 20, 1893
*Durham, Arthur Edward	May 7, 1895

* Honorary.

Name	Date of death
*Erichsen, Sir John Eric	September 23, 1896
*von Esmarch, Friedrich	1907
Fenger, Christian	March 7, 1902
Ferguson, Alexander Hugh	October 20, 1911
Forbes, William Smith	December 17, 1905
Fowler, George Ryerson	February 6, 1906
*Friedrich, Paul Leopold	January 5, 1916
Gaston, James McFadden	November 17, 1903
Greene, W. Warren	September 10, 1881
Gross, Samuel David	May 6, 1884
Gross, Samuel Weissel	April 16, 1889
Gunn, Moses	November 4, 1887
*Gussenbauer, Karl	June 19, 1903
Guthrie, George Washington	June 1, 1915
Harrington, Francis B.	1914–1915
*Harrison, Reginald	1907
Hearn, W. Joseph	December 20, 1917
Hodge, H. Lenox	June 16, 1881
Hodgen, John T.	April 28, 1882
Homans, John	February 7, 1903
*Horsley, Sir Victor Alexander, C. B.	July 16, 1916
Horwitz, Orville	January 28, 1913
*Horwitz, Phineas J.	September 28, 1904
Hughes, J. C.	August 10, 1881
*Humphrey, Sir George Murray	September 24, 1896
*Hunt, William	January 5, 1897
Jacobson, Nathan	September 16, 1913
Johnson, Alexander B.	September 4, 1917
Johnston, George Ben	December 20, 1916
Johnston, Christopher	October 11, 1891
King, Alfred	June 4, 1916
Kinloch, Robert Alexander	December 23, 1891
*Kocher, Theodor	July 27, 1917
Lane, Levi Cooper	February 18, 1902
*von Langenbeck, Bernhardt	September 30, 1887
Levis, Richard J.	November 12, 1890
*Lister, Joseph	February 11, 1912
Little, James Lawrence	April 4, 1885
Lutz, Frank Joseph	March 24, 1916

* Honorary.

Name	Date of death
McCann, James	1893
McCosh, Andrew J.	December 3, 1908
McGuire, Hunter	September 19, 1900
*MacCormac, Sir William	December 4, 1901
MacDonald, Willis Goss	December 30, 1910
MacMonagle, Beverly	May 22, 1912
Markoe, Francis Hartman	1907
Marks, Solon	1916
Mastin, Claudius Henry	October 3, 1898
Mears, J. Ewing	May 28, 1919
Michael, J. Edwin	December 7, 1895
*Mikulicz-Radecki, John V.	
Miles, Albert B.	August 5, 1894
Millard, Perry H.	February 1, 1897
Miller, Truman W.	May 31, 1900
*Moore, Edward Mott	March 3, 1902
Moore, James E.	November 2, 1918
Mudd, Henry Hodgen	November 20, 1899
Mumford, James Gregory	October 18, 1914
Murphy, John B.	August 11, 1916
Norris, Basil E.	October, 1895
*von Nussbaum, J. N.	October 31, 1890
*Ollier, Leopold	1900–1901
Oviatt, Charles W.	October 31, 1912
*Paget, Sir James	December 30, 1899
Pancoast, William H.	January 5, 1897
Park, Roswell	February 15, 1914
*Parker, Willard	April 25, 1884
Parkes, Charles T.	March 28, 1891
Parkhill, Clayton	January 16, 1902
*Péan, Jules E.	January 30, 1898
Peck, Washington F.	December 30, 1891
Pilcher, Paul Monroe	January 4, 1917
Porter, Charles Burnham	May 21, 1909
Porter, William Gibbs	January 30, 1906
*Pozzi, Samuel	1918
Prewitt, Theodore F.	October 17, 1904
Prince, David	December 19, 1889

* Honorary.

Name	Date of death
Reed, Thomas Baird	April 1, 1891
Richardson, Maurice Howe	July 31, 1912
Richardson, Tobias Gibson	May 26, 1892
Rodman, William Louis	March 8, 1915
Sabine, Thomas Taunton	August 23, 1888
Sayre, Lewis A.	1900–1901
*Schede, Max	1902
Senn, Nicholas	January 2, 1908
*Sims, J. Marion	November 13, 1883
Squire, Truman Hoffman	November 27, 1889
*Terrier, Louis Felix	1908
*Thiersch, Karl	April 28, 1895
Thompson, Joseph Ford	February 1, 1917
Thompson, Joseph W.	March 30, 1886
Thomson, William	August 3, 1907
Tiffany, Louis McLane	October 23, 1916
Varick, Theodore Romeyn	November 23, 1887
*Verneuil, Aristide A. S.	June 11, 1895
*von Volkmann, Richard	November 28, 1889
Watson, Beriah Andrew	December 22, 1892
Weeks, Stephen Holmes	September 1, 1909
Weist, Jacob Rowland	May 14, 1900
*Wells, Sir Thomas Spencer	January 31, 1897
White, James William	April 24, 1916
Wight, Jarvis S.	November 16, 1901
Willard, DeForest	October 14, 1910
Wood, James R.	May 4, 1882
*Yandell, David Wendell	May 2, 1898

* Honorary.

REPORT OF COMMITTEE ON NECROLOGY

JAMES EWING MEARS, M.D.

Dr. James Ewing Mears was born in Indianapolis, October 17, 1838, and died in Philadelphia, May 28, 1919, in his eighty-first year. He was the son of Dr. George Washington and Caroline Sidney (Ewing) Mears. He graduated from Trinity College, Hartford, Connecticut, with the A.B. and B.S. degrees in 1858. In 1861 he was awarded his A.M. degree, and in 1908 had conferred upon him the honorary degree of Doctor of Laws by his alma mater. He never married.

In 1865 he graduated in medicine at the Jefferson Medical College of Philadelphia. He soon became one of the instructors of anatomy and surgery in Dr. W. W. Keen's Philadelphia School of Anatomy. Subsequently he was appointed demonstrator of operative surgery in Jefferson Medical College, having for his duty the organization and directionof the newly established surgical laboratory. Later he became gynecologist and lecturer on gynecology in the Jefferson Medical College Hospital.

During the Civil War he first served as a medical cadet and later as executive officer in military hospitals. Thus early in Dr. Mears's life was recognized his eminent ability in executive positions. This faculty received due recognition by the medical profession of Philadelphia. Any function requiring personal attention to business details was very likely to be entrusted to him, and with the feeling that it would be carried to success.

From 1870 to 1898 he occupied the chair of professor of anatomy and surgery in the Pennsylvania College of Dental Surgery. He also served as attending surgeon to St. Mary's and St. Agnes's Hospitals. It was in St. Mary's Hospital that he and his other colleagues were the first surgeons of Philadelphia to adopt Lister's antiseptic method, a fact commemorated by a tablet in that hospital. In addition to his excellent work in general surgery he gave special attention to oral surgery and wrote a valuable article on "Ankylosis of the Lower Jaw," embodying the results of his opportunities for study in the dental institution to whose faculty he belonged.

His interest in surgery of the abdomen dated from an experience in the Philadelphia Blockley Hospital, now known as the Philadelphia General Hospital, in which in his earlier years he served in the surgical department. Upon one occasion a patient under his care who had died was to be subjected to an autopsy. Young Mears was astonished to find a scar in the abdomen, which led to an inspection of the pelvic organs. He then discovered that in addition to the distant lesions causing death there was an absence of one ovary. He reported this fact to Dr. Washington L. Atlee, the early ovariotomist of Philadelphia, who had done an ovariotomy for tumor upon this patient some years before. Atlee had been so greatly condemned by the profession for removing ovarian cysts that he was deeply interested in securing the specimen from this autopsy, through the acute young surgeon, which proved his contention that ovarian cysts could be treated successully by abdominal section. As a result, Mears became a frequent assistant at the ovariotomies of the older man and assisted in the publication of his cases.

Dr. Mears was a charter member of the American Surgical Association (1880) and its recorder from 1881 to 1893. At the latter date he was elected president of the Association. He for a good many years served as secretary of the Philadelphia Academy of Surgery and later became its president in 1898. He was a charter member of the organization (1879). In the College of Physicians of Philadelphia, he showed his deep interest by editing its *Transactions* from 1872 to 1888 and founding the J. Ewing Mears Library Fund, of five thousand dollars. Some years before his death he presented a valuable medical library and an endowment in memory of his father to the local medical society of his native city.

He was an honorary member of a number of medical societies and an active contributor to many medical journals and to the *International Text-book of Surgery*. It was his pleasure and pride to aid worthy young men in their academic and medical studies.

His interest in horticulture and forestry led him to important service in the Philadelphia Horticultural Society, of which he was a life member; he was also a member of the Massachusetts Horticultural Society, of the Philadelphia City Parks Association and of the Pennsylvania Forestry Association.

After his retirement from active practice, about twenty years ago, he travelled extensively in the United States, also visiting Europe, Asia and Africa. His death makes a distinct loss to his chosen profession and to his many friends, especially in the Association.

W. W. Keen.

THEODOR KOCHER

THROUGH the death of THEODOR KOCHER, who passed away in Berne, July 27, 1917, the American Surgical Association lost one of its most important honorary members. Kocher's pioneer work in so many branches of surgery has had a great influence in raising that science to the position it holds today; indeed, of him it may be said more truly than of any other surgeon during the last twenty years, that he was "international."

On examining the reasons of Kocher's success we find that it was partly due to certain favorable circumstances, without which it might not have been possible for him to achieve all that he did. Born August 25, 1841, he was appointed in 1872 professor to the surgical clinic in Berne at the early age of thirty-one years. Consequently, while still a young man, he had a splendid opportunity of gaining wide surgical experience and of developing his intellectual gifts in all directions. He held the professorship for forty-five years, and therefore acquired a wealth and variety of material for observation and research such as falls to the lot of few surgeons. Again, it is important to point out that the beginning of Kocher's activities fell in the period in which the introduction of antisepsis led to hitherto undreamt of advances in surgery. Indeed, with the exception of the last three years, Kocher's whole lifework fell in a favorable period, as the progress of scientific work was neither interrupted nor retarded by any great international disturbances.

But these are merely the extraneous conditions which made Kocher's work possible: The real reasons for his success are to be found in the man himself. Kocher had the truly scientific mind. He always endeavored to penetrate to the root of things and would not accept traditional explanations without proving them to have a sound anatomical and physiological basis; he was not content to stop when he had attained his immediate aim, and he always regarded progress merely as a step toward ultimate perfection.

By his conscientious attention to detail, Kocher differs from what is usually called "genius;" at the same time the originality of his ideas and the intellectual stimulus which he gave to his whole generation raise him far above what is usually called "talent."

Kocher's work was spread over many departments of surgery, and not one of his contemporaries has had such a far-reaching and stimulating influence in so many of its different branches. A great advance was made in cerebral surgery, thanks to his studies on compression and concussion of the brain and to his methods of operation. His

clinical papers on injuries of the spine and of the spinal cord made him a leader in this subject.

In the surgery of the neck, Kocher is responsible for much of the knowledge that has been gained with reference to the pathology and therapy of goitre. He was the first to make a thorough clinical study of cachexia thyreopriva; he worked out in detail, on a sound anatomical basis, the technic of the operation for goitre, and up to his death he was specially occupied with functional disorders of the gland—hyperthyroidism and Graves's disease and hypothyroidism, along with myxedema and cretinism. What he achieved in this sphere alone would suffice for a man's lifework.

He was one of the pioneers in gastro-intestinal surgery. His method of resection of the pylorus is still considered the best by many surgeons. In urogenital surgery we owe to Kocher the classical studies on diseases of the testicles. He was one of the leaders in the operations for hernia.

In surgery of the extremities, Kocher early made himself known by his method of reduction of dislocations of the shoulder. His researches on complicated fractures, especially in the neighborhood of the large joints, have been fully confirmed by *x*-rays and form the basis of the descriptions which are given of these injuries in modern text-books. His carefully elaborated methods of joint resections, especially in cases of tuberculosis, bring us to a work which has rightly made Kocher's name famous, namely, his *Text-book of Operative Surgery*. By means of this book, Kocher has made his operative technic—which is carefully based on anatomy as well as on physiology—the common property of the whole surgical world, and has won for himself followers not only among those who listened to his lectures and addresses at Berne and at the various congresses he attended, but also among surgeons throughout the whole world. In this book we have an example of the clear method of demonstration and keen logical sense which characterized all Kocher's teaching. These two qualities made him one of the best teachers of surgery of his time. His pupils were attracted to his clinic, not so much by the brilliancy of his teaching as by the amount of sound knowledge they knew was to be gained from him and by the excellent training in consistent and logical reasoning which they all received.

Up to the time of his death, Kocher showed a keen interest not only in the progress of surgery, but also in that of the natural sciences in general. An example of this may be seen in the part he took in the founding of a bacteriological laboratory in Berne. His work on gunshot wounds, his investigations in connection with brain compression, his experiments in the treatment of tetanus by sulphate

of magnesium, all witness to his constant interest in the subsidiary sciences and to his eagerness to make use of them to further the advance of surgery.

A lifework such as Kocher's demanded not only exceptionally favorable outward conditions, an unusually long and uninterrupted period of work and all the special qualities with which Kocher was by Nature endowed, but it demanded also complete absorption in his subject, and this sacrifice Kocher was willing to make. Indeed, to him, it seemed to be no sacrifice; his whole interest was centered in his surgery, and to him it was recreation as well as work. Kocher was a surgeon pure and simple, in contrast to Horsley, who was also a politician, and to Billroth, who devoted his attention to music as well as surgery.

As may be readily understood, Kocher, during his long lifetime, was the recipient of many national and international honors. He was also appointed President of a large number of congresses, and on each occasion he distinguished himself by the tactful manner in which he conducted the proceedings.

Surgeons in every country owe to Kocher a deep debt of gratitude, and his death, though at the close of a long career, meant a great loss to the world. H. J. S. and F. de Quervain.

DR. GWILYM GEORGE DAVIS

Dr. Gwilym George Davis died at his camp near Kineo, Maine, June 16, 1918. He was born in Altoona, Pennsylvania, July 20, 1857.

He received his degree as Bachelor of Arts from the Central High School of Philadelphia in 1876 and that of Master of Arts in 1881. He received his degree as Doctor of Medicine from the University of Pennsylvania in 1879 and from the University of Göttingen in 1881, and became a member of the Royal College of Surgeons of England in 1880. He served as resident physician in the Pennsylvania Hospital 1881 to 1882, and was afterward appointed an attending surgeon to the Lankenau, Episcopal and St. Joseph's Hospitals as well as to the Philadelphia Orthopædic Hospital and Infirmary for Nervous Diseases.

During the winter of 1917–1918 he worked very hard as a member of the Advisory Orthopedic Commission to the Surgeon-General, teaching Military Orthopedic Surgery at the University of Pennsylvania, which, with his undergraduate teaching as well as his hospital and private practice, overtaxed his strength, and he was taking a

well-earned holiday in the Maine woods, where he was taken ill and died of pneumonia. He never married.

From 1900 to 1911 Dr. Davis was associate professor of applied anatomy in the University of Pennsylvania when he was elected to the chair of orthopedic surgery, and continued to serve in the latter capacity until his death. He was a fellow of the American Surgical Association, past president of the American Orthopedic Association, at one time president of the Philadelphia Academy of Surgery, a member of the Society of Clinical Surgery, American Medical Association, the College of Physicians of Philadelphia and various other societies.

For many years he practised general surgery, finally limiting himself to orthopedic surgery, and to this he attributed much of his success in this latter specialty, for a man to be a thoroughly sound orthopedic surgeon must first be an all-round general surgeon.

W. J. T.

DR. JAMES EDWARD MOORE

Dr. James Edward Moore was born March 2, 1852, in Clarksville, Pa., and died November 2, 1918, in Minneapolis, of pernicious anemia. He was the son of the Rev. George W. and Margaret (Ziegler) Moore.

As a boy he attended the public schools of Pennsylvania, going later to the Poland Union Seminary, at Poland, Ohio, and from there to the University of Michigan. He received his medical degree from Bellevue Hospital Medical College in 1873. The year after his graduation he practised in Fort Wayne, Indiana, returning to New York for work in the hospitals. In 1876 he established himself in Emlenton, Pennsylvania; here for six years he performed the strenuous work of a country practitioner, making most of his calls on horseback and dispensing from his saddle-bags.

In 1882 he migrated to Minneapolis, Minn., where he practised until 1885, when he went to Europe for study in London and Berlin. Returning in 1887 he announced that he would confine his practice exclusively to surgery.

Always interested in medical education, Dr. Moore, upon the organization of the Medical School of the University of Minnesota, became identified with the faculty of that institution, holding in succession the positions of professor of orthopedic surgery, professor of clinical surgery, professor of surgery, and in 1908 he was made

chief of the department of surgery, and held this position until his death, November 2, 1918.

Dr. Moore was a born teacher, having the rare gift of imparting knowledge, presenting his theme in such a simple, terse, logical manner as to carry conviction and to clinch the facts in the memories of his auditors; his earnest enthusiasm won the respect and admiration of his associates and students; gifted with native eloquence, a quiet dignity and a logical mind, his address carried conviction; he was forceful yet temperate, and restrained in his utterances and actions.

Throughout the years, successive generations of students sat at the feet of this master teacher of surgery—students who now all over the land mourn the loss of professor, comrade and friend. He was a virile, convincing writer, having presented over two hundred papers on surgical subjects. He was the author of sections in various American systems of surgery, and in 1898 he published *Moore's Orthopedic Surgery*. His writings and discussions won him recognition at home and abroad, and he early became identified with the representative surgical societies, affiliating with the American Surgical Association, and being its vice-president in 1905; with the Western Surgical Association, being president in 1902; chairman of the Surgical Section of the American Medical Association in 1903; member of the Southern Surgical Association; member of the Judicial Council of the American Medical Association; fellow of the American College of Surgeons and member of the board of governors; member of the Société Internationale de Chirurgie; of Nu Sigma Nu; of the Minnesota Academy of Medicine and of the local State and county societies

To the many who were permitted to know Dr. Moore well and to the few who were privileged to be his intimates, the charm of his personality, his simple, manly creed, his love of justice and fair play, his intolerance of incompetence and sham, his charity for human weakness and frailty, his keen appraisement of character, his fearless championship of right, and above all his great human sympathy for those in trouble or distress—one and all were traits which appealed and bred love, respect and deference.

For thirty-six years Dr. Moore left his imprint on the medical life of the Northwest; his influence, example and skill during these years ever helped to blaze the trail, to mold and stimulate toward the best and highest type of surgery. As a teacher, surgeon and friend he was a constant inspiration, his example and life a model to shape the destinies of his students and inspire the emulation of his fellows. A. A. L.

ADDRESS OF THE PRESIDENT

THE INFLUENCE OF WAR SURGERY UPON CIVIL PRACTICE

By LEWIS STEPHEN PILCHER, M.D.
BROOKLYN, N. Y.

When at the opening of the Congress of the International Surgical Society in New York in April, 1914, President Depage announced as the theme of his inaugural address "War Surgery," it came as a distinct surprise to the great mass of those who were assembled to listen to him, for nothing was farther from the thought of the scientific world at that moment than War. Indeed, the very existence of the society before whom the address was being made was an evidence of the universal expectation of a continuance of that peace which for so many years had prevailed among the controlling nations of Europe. In the assembly to which his words were addressed were eminent representatives of England and France, of Belgium and Germany, of Russia and Italy, of Denmark, Norway, Sweden and Finland, of Austria, Poland and Hungary, of Holland and Portugal, and Roumania, all guests of the surgeons of North America. Was not such an assembly a guarantee of the continuance of that peace of the triumphs of which those men were such eminent representatives? And yet, before the pages of that address appeared in print, the fateful third of August had arrived and the world was plunged into a strife which was to array these men as enemies,

each to the other; was to array in battle sixty millions of men and was to cause the direct loss from the world's workers by death on the battlefield, or later from the wounds there sustained of more than ten millions of men.

Five years have passed, years the most tragic and historic of all the centuries. All of those men who were our guests five years ago have been compelled to devote their entire thought and labor during these years to the surgery of war. Some of them have suffered the supreme sacrifice which war exacts from its devotees. Of the active members of the American Surgical Association itself a large proportion have worn the uniform of their country's service, and of the remainder there is not one who has not regretted that, by reason of years or by reason of the importance of civil duties which could not be transferred to other hands, it has been impossible for him to follow the example of his younger colleagues.

Today as we see the approach of peace it is possible for us once more to concentrate our thoughts upon the problems and duties of ordinary life. We welcome again the appearance among us of our colleagues who have been in service abroad, as well as those whose duties have kept them in the encampments at home. The memories of the past and the pleasures of the present in this reunion unite to give to this meeting of our Association a special spirit in which interest and pride and affection, memory and anticipation, unite to form a bond that brings us more closely together than ever before.

It is with the highest satisfaction, also, that we welcome the presence of representative surgeons from such countries as Belgium, France and Great Britain, to help whom in the tremendous burdens which the recent strife thrust upon them, has been the glad opportunity of so many of our number, and whose unfailing courtesy and grateful appreciation have been demonstrated to their American confrères in so many ways and upon so many occasions. We feel that we are honored by their journey across the Atlantic to be present at this meeting and we extend to each of them our cordial greeting and fullest homage, and

through them we send to the countries which they represent our most grateful appreciation of the years of struggle and sacrifice which they have made in their labors to protect the world from an assault aimed at the foundation principles of civilization, a strife to share in which it was ever our duty and finally our privilege.

It is proper that we should pause a moment to do honor to the memory of those colleagues of our own blood who in this recent contest sacrificed their lives in obeying their country's call. From first to last nearly 35,000 American physicians donned the khaki and the blue of the Army and Navy as a patriotic duty. To by no means all of this number[1] was it given to go overseas and of those who did cross the Atlantic, a very considerable portion were prevented by their duties from reaching the front before the sudden and unexpected collapse of the enemy power removed at once the need for that service. All alike, however, were animated by the same spirit, and to all are due the credit and honor which belong to the highest professional zeal and deepest patriotic devotion.

It is impossible to speak in too high terms of the character of the personnel of which the Medical Corps of the American Expeditionary Force was composed. They were men, not only inspired with patriotic devotion and filled with the hopefulness and progressiveness of youth, and early manhood, and possessed of ability to endure hardship and labor, but in large proportion they were men of thorough and long training, many of them of large hospital experience, many specialists of distinction, keen in their professional spirit, enthusiasts in their work, ready and eager to cope with the surgical problems, however colossal, which demanded attention and solution. Of these, our companions, our pupils, in some cases our sons, who were of that number who were privileged to share the dangers of the enemy's offensives, 46 were killed in action; 22 died later of wounds received

[1] The total number of officers in the Medical Department sent overseas is as follows: Medical Corps, 14,358; Dental Corps, 1924; Veterinary Corps, 887; Sanitary Corps, 1333. Total, 18,494.

in action; 212 received wounds from which they survived; 38 were taken prisoners; 7 are registered as missing in action; and 4 were lost at sea. This is a record which would do honor to any body of men and is especially splendid for men deemed to be non-combatants; who were animated not by the special enthusiasm of combat, nor by the expectation of military fame or reward, but by that professional spirit peculiar to medical men which has ever caused them as a class to ignore danger and fatigue, and inconvenience of any kind in the performance of duty. The duty of the surgeon is ever to save life, to relieve the suffering and when, in the performance of such duty, he loses his own life does he not illustrate in the highest degree the spirit of the Great Teacher, "Greater love hath no man than this, that a man lay down his life for his friends?"

For the first time in supposedly civilized warfare, hospitals were selected as the special target of attack by an enemy's gun. The Red Cross was no longer sacred and the operation pavilion, or a nurses' home, was the object of an aërial bomb, as much as an ammunition train, or a depot of military supplies.

With reason, therefore, do we claim that the medical officer at the front and those assistants of humbler rank who shared his dangers and his labors are among the heroic figures of the war to whom due honor should ever be paid. It has well been said that none who have not experienced the stress, the anxiety and the limitations of surgical work during severe fighting can appreciate the problems and the difficulties of the work which had to be done under such surroundings; to which should be added as well, the dangers which they shared equally with those who were recognized as combatants.

To the memory of those of their number who under such circumstances lost their lives, their colleagues cannot pay too high honor. Those who sealed their devotion to duty, their patriotic fervor and their professional enthusiasm with their blood, who sleep now beneath the sod of a foreign soil, these are *our* heroes. They belong to a legion of honor more illustrious than that of any modern government; they wear a decoration of special merit

awarded to them by their fellows of a universal brotherhood who best and most fully understood their merit. The cross that marks their graves indicates a distinguished service of which no other badge could be more significant. We honor ourselves as we hasten to place about their names ever renewed chaplets of laurel!

The war is over and we may now turn our thought as surgeons to garner its lessons, estimate its results, and place to future practical account its teachings. Animated by this idea, I have chosen as a theme suitable for the Presidential Address in this Victory Year, "The Influence of War Surgery on Future Civil Practice."

I am not unmindful of the fact that we are yet too close to recent events to fully appreciate them in their proper relations, or to know what the ultimate influences that they may exert may be. Still there are even now certain things that are plainly discernible, and it is inevitable and advantageous that we should begin at once to take account of the new conditions and possibilities that have been demonstrated in the peculiar and vast experience of these years of warfare, and to speculate, also, upon the future changes which present conditions indicate. From many angles may be viewed the influence of the experiences gained in such conditions as those supplied by a war of such magnitude as the one through which the world has just passed, even when attention is confined to the single field of surgery, but it is only upon some of the larger, broader lines of the subject that I shall dwell at this time.

In this connection, the effects produced in the professional life and character of this country by the four years of the Civil War of 1861–1865, naturally at once present themselves to the mind of one who shared personally in the experiences of that time and has been able to see and feel the effects which that war produced upon American surgery. This association is fortunate that among its Senior Fellows still remain some men who personally shared in the experiences of that great war. Keen and Vander Veer, Nancrede and Weir still survive to benefit

us with their counsel and to recall to our memory the trials and accomplishments of those days. May we not look to them now as to "Elder Statesmen" to strengthen, to judge, or possibly to correct, my own estimate of the effects upon civil practice of the surgery required and developed in the conditions of war?

The effects of war upon surgery and surgeons, and upon the attitude of the public mind to surgery and surgeons is a fairly certain reaction. The times and men change, but the general effects are the same. Before 1861 the field of surgery in this country was a very narrow one. To it very properly belonged the term "External Medicine." Operative attempts were of rare occurrence and of but little importance except in the hands of a very few especially gifted and energetic men. The treatment of fractures and the various procedures of minor surgery constituted the full scope of ordinary surgery. The highest achievements of leaders in surgery were found among amputations, lithotomies, arterial ligations for aneurism and the removal of superficial tumors; some bold men were beginning to remove ovarian cysts. Inflammations, suppurations and gangrene were the common attendants of surgical effort that rendered its results uncertain and deterred all excepting the boldest spirits from attacking its problems.

The traumatic surgery of the war for the Union fifty-five years ago awakened the slumbering surgical spirit of the American medical profession and when peace was declared in 1865, there returned to their homes, North and South, more than 25,000 medical men who had become familiar with the most exacting of surgical emergencies to meet which they had been trained in conditions that called forth quickness, fortitude and self reliance in an eminent degree. Their confidence in themselves had been awakened, their energy and experience had been broadened and their interest in surgical problems had been increased. But not alone was this surgical baptism enjoyed by commissioned officers. There was a great host of enlisted men who by reason of their hospital experiences, as patients, as nurses, as ward masters, as hospital stewards, had been made familiar with surgical work

and had had their interest aroused in its problems, so that during some years immediately succeeding the close of that war, the medical schools of the country were crowded with men whose interest in medicine and especially their enthusiasm for surgery, had been awakened by the experiences of that war. Hardly had these men returned to their homes, military surgeons and the graduates of army hospital wards, when the relations of micro-organisms to infection, and of infection to surgical catastrophes, were demonstrated, the whole field of surgery was immensely enlarged and there was presented to their eager minds a fallow field inviting their labors, the results of which were no longer uncertain and capricious.

One of the by-products of this awakening of the surgical spirit in the American profession was a constantly increasing appreciation among its leaders of the desirability and importance that the surgery of America should have a representative body. This fully culminated, finally, in the conference at Atlanta in 1879 at which the American Surgical Association was born. What a peace conference that was, when from New Orleans, Mobile, and Charleston, Boston, New York, Philadelphia, and Cincinnati, Chicago, San Francisco, St. Louis, Louisville, Nashville, and Richmond, assembled surgical leaders who a few short years before were arrayed against each other in fratricidal strife, now to unite in the formation of an association which was to typify a united America! It is not too much, indeed, to say that the very existence of the Association which has called us together today, is one of the effects of "War Surgery Upon Civil Practice."

It is along similar lines, therefore, that I am inclined to think will be found the most important effects upon civil practice of the surgery of the recent World War. Surgeons of this war, after the experiences which they have had, both in the more trying conditions on the fields of combat and in the highly important demands to which they have been subjected in the base hospitals both abroad and in the cantonments of concentration at home, cannot escape the higher endowment which attends the enlargement in the scope of their surgical vision; which inevitably has heightened

and broadened their professional aspirations, and which has resulted in a higher grade of attainment both in the science and art of their chosen profession, and which has greatly increased their usefulness as individuals in bringing relief to their fellow men. Perhaps the chiefest element in this mental change which has steadily grown out of the conditions of their daily work is an appreciation of the value of coöperation with their fellows to the end of diagnosis and *pari passu* with this an increase of mutual respect and a lessening of individual rivalries and an increasing devotion to the highest attainments of science. The most important effect of the recent war was upon the surgeons rather than upon surgery. Never before in the history of warfare have the merits and value of the medical staff for consideration as parts of the military machine been so fully acknowledged as in the war now closed. In an army there is one unfailing criterion as to the importance of a man and that is *rank*.

I have recently been rereading Fielding Garrison's charming and sympathetic biography of our late colleague, John Shaw Billings. Billings was commissioned an assistant surgeon in the United States Army in April, 1862. He was soon in charge of a great base hospital in Georgetown. He later was assigned to field duty with the Army of the Potomac, and had large responsibilities in the care of the wounded from the battles of Chancellorsville and of Gettysburg. As an inspecting medical officer, he was charged with important duties during the campaign of the spring of 1864, and finally, was assigned to duty in the Surgeon General's Office at Washington in December, 1864, where his erudition, his intellectual poise, his judgment of men, his unremitting industry and his great administrative ability enabled him to be of such great service to his country and to his profession for the succeeding fifty years. And yet, Billings, with his ability and his record saw no promotion in military rank during all the years of war. As an assistant surgeon, with the rank of first lieutenant, he entered the army in 1862, and he was still a first lieutenant when the victorious hosts of Grant and Sherman made their triumphal march down Pennsylvania Avenue in 1865!

In this most recent of wars, in which there first appeared a willingness to grant to medical men degrees of rank suitable to the responsible and important duties belonging to them, an appropriate acknowledgment of the inseparable qualities of hygiene and surgery as handmaids to sound strategy and combatant force to ensure ultimate victory. I take it, my colleagues, that this is a consideration that concerns us so much, both as citizens and surgeons, that we might well express our appreciation of the wise and admirable methods whereby this most desirable and important change has been accomplished.

I mention it now, however, because of its place in the chain of conditions that have had an important influence upon the character of the surgeons who have so recently shared in the military spirit of their country's armies. It has to do with that intangible, undefinable, altogether admirable thing which we call "*morale*" which is the surest precursor of success and the most important element in the attainment of ultimate victory. Nothing contributes to it more than a sense that those for whom we labor, confide in us, depend upon us, honor us. In the military life this has its highest expression in what is called *rank*. The American Congress, when it established in the medical corps of the recent army the higher grades of rank with which it is now honored, at once not only gave to that branch of the service the recognition which its importance deserved, but with it increased in a notable manner the morale of the whole service, as it granted to so large and important an element of it such assurance that it confided in it, depended upon it, honored it. Every member of the medical staff of this army has felt the influence of this new attitude of their government to them, and each one in returning to his home and resuming the duties of civil life, will continue to feel its broadening and stimulating influence to a higher degree of professional work.

The compactness of the territory within the limits of which the chief contests of this war have taken place; the comparative stability of the areas of combat and the great prolongation of the struggle made it possible for the surgeons of the forces from all

parts of the extended front, by mutual conferences affording personal exchange of experiences, to early establish a progressively improving standardization of methods of practice; a standardization which contributed greatly to the remarkable degree of efficiency ultimately attained. The various allied governments apparently vied with each other in effecting organizations that could provide to the fullest possible degree for the needs and exigencies of the demands of their armies for surgical relief, including hospitals, matériel, literature, and methods of supply and of evacuation, all of which contributed greatly to the encouragement, the inspiration and the positive assistance of surgeon and patient. The ubiquity of the organization and the instant readiness with which the agents of the Red Cross responded to emergent calls for helpers and for supplies of every kind wonderfully supplemented the slow movements through official channels. Each element, official and volunteer, contributed a share in bringing about the results of the surgery of this war, as each has been an element in making possible the final measure of successful relief secured.

To one who has occupied a point of view so peculiarly detached and so broadly and deeply sympathetic as that in which your speaker has been placed, who from the circumstances of his own early years of military service ashore and afloat, in time of war and in time of peace, has been able to realize the many-sided character of the relations of surgical organization and of surgical work in the military ensemble of the great war, the one great thing that stands out as the preëminent feature in the surgery of this latest war is the fullness with which the military importance of the provisions for surgical relief and sanitary prevention has been recognized by the governments involved. We may be sure that there will be no step backward in the future. The magnificant results which the surgery of the war has shown have forever closed the mouths of those who would belittle the position of the "Doctor in War." The thought which is in my mind in this connection, however, has to do more especially with the effect upon the medical men themselves which this recognition has produced.

When the newly appointed medical officer first entered the training camp to which he was sent, he began at once to appreciate that he was a part of a great military machine whose spirit he must imbibe, in whose labors he must bear an important part and whose dangers and whose glories he was to share. The transformation in his mentality, in his sense of relation to his fellows, in his grasp of the real values of life's problems which rapidly took place in him, can never be reversed. When he is finally mustered out of the service and resumes his life as a civilian, he does not and cannot return to the same status which he occupied when he first assumed the military dress. There has inevitably been awakened in him a divine dissatisfaction with the old life and a longing after a higher standard of professional attainment and life. His professional spirit has been heightened, strengthened and chastened. This direct fruition of war-time conditions has been experienced by some in greater degree than by others, but no one has escaped its influence in some degree. This, then, is the highest, most important, most beneficent of contributions of the surgery of this war to the civil life of the nation, namely, a quickened, ennobled, more efficient body of surgeons; a body of men who in the hard school of war have received an endowment of enthusiasm, an illumination of spirit, and an ability to persevere and conquer success under difficulties which they will carry with them during the remaining years of their life, and which qualities in some measure they will transmit to, or create, in their successors.

Without in any way minifying the extraordinary results which they have attained in the surgical efforts of this World's War, it is not true that in general these results are but demonstrations and applications, though often upon a colossal scale, of principles and truths which the work of the previous fifty years had been accumulating for its use, rather than the development of any new and important principle which, with the disappearance of the special conditions of combat destructiveness, will remain to us as a permanent addition to surgical practice to modify the surgery of civil life hereafter.

It is true that the exigencies of war have produced many modifications and adaptations of surgical technic. New antiseptic agents and combinations have been introduced. The scale upon which work has had to be conducted has been immensely enlarged beyond that ever called for in civil practice. The wounds which had to be cared for, as a rule, presented more extensive lacerations and were the subject of more intensely virulent infections than had ever before been met with in warfare. The urgency of the work was at times overwhelming and the provisions for desirable technic were often unavoidably inadequate. Notwithstanding all these facts, we now see that through the perfection of the organization of surgical relief which was accomplished the surgical methods adopted for the treatment of this vast traumatic surgery were better than those witnessed ever before in warfare.

The traumatic surgery of this war has constituted a tremendous vivisection experimental laboratory in which not mice, nor rabbits, nor guinea-pigs, nor dogs have been the subjects of experiments, but human beings, the choicest young men of the civilized world. To the solution of the problems of the surgery of the last and greatest war was concentrated the experience, the researches, the labors, the maturest surgical thought of all the years to which the traumatic surgery of 1861–1865 was a prelude, years during which surgery became so largely a science, definite, positive, certain, as well as an art, wonderful and merciful in its results.

The stations for first aid, the casualty clearing stations and the base hospitals, formed a series of provisions for relief that provided in succession for supplying the needs of every emergency in the progress of the wounded man from the reception of his injury upon the open field or in the trench to his ultimate return to duty as a cured man in a degree that compels our astonished admiration at its fulness and its success. It is true that in the earlier days of inexperience and confusion there was registered much of disappointment and failure in the provisions for relief that were made. We do not close our eyes to the enormous amount of suppuration and gangrene which developed in the

wounds of that time. The manner in which, however, these conditions were mastered and the reasons for them appreciated and overcome, and the ultimate success of the surgery attained, forms one of the most remarkable and triumphant chapters in the history of surgery.

It is true that in the urgent stress of combat conditions, there was often haste and crudity in the methods employed. The shifting battle conditions produced at times an enormous disproportion between the demand for work and the possibility to respond to it. There were days of unavoidable irregularity and urgency of demand that discounted all anticipation, but never before was so perfect an organization evolved for bringing early and adequate surgical relief to the wounded.

The accumulated statistics of the war, notwithstanding all its inevitable disasters and failures, show that more than 90 per cent. of all wounded men who lived to come under surgical care recovered from their wounds and that from 70 to 80 per cent. of all casualties were able to return to duty within two months. Any study of the specific details of the practical surgery which was elaborated and carried out to bring about such a result cannot be entered upon at this time.

These details form chapters in the surgery of war which will ever be of the highest importance, not only as presenting surgical effort in its most exalted phases, but also as lessons of supreme value in directing the surgery of the future, not only in conditions of warfare, but in the civil practice of times of peace. The careful studies of the subject of shock, with its demonstration of the possibility of carrying on, even in conditions immediately behind the line of battle, such a procedure as blood transfusion, the widespread, almost universal use of prophylactic injections of the antitoxin to forestall tetanus, the practical establishment of minute details whereby sepsis was controlled and antisepsis made efficient, and above all, the demonstration and universal adoption of methods of early surgical resections of wounds whereby they were converted into clean wounds, the ultimate healing of which was no longer an uncertain and prolonged process, but became a sure and rapid exhibition of primary

healing; and those results which were obtained by the surgery of various regions, the surgery of the brain, and that of the peripheral nerves; the surgery of the face, the surgery of the chest, as the result of which the thorax, which for so long a time had been practically a closed area to surgical effort, was demonstrated to be as accessible and as promising a field as any other portion of the body; the abdomen and the extremities, with which latter are associated the problems of bone and joint infections; all these have already been the subject of intensive studies and in each department of which most important contributions have been made by Fellows of this Association who now sit before me. These in their order and place will occupy our interested attention for years to come.

It is most notable that steadily from the beginning to the close of the conflict in every line of effort, better and better results were being secured and more successful responses to the emergent needs of wounded men were being made. Who can say how great a contribution in the production of the magnificent morale of the allied troops which carried them on to final victory was the knowledge which these men had of the care which they would receive should wounds and disease overtake them?

With full appreciation of the record which surgery has made in this vast school during these four years of intense strife, is it not true that they present, not so much the wonderful results of new discovery, or the brilliant work of some group of extraordinary surgical geniuses, but rather the constant, full value of sound surgery, the possibility of applying even in the conditions of combat fundamental surgical principles, worked out by a body of men endowed primarily with the elementary surgical instinct, but now illuminated and heightened by the peculiar influences of patriotic fervor and high ideals, and made practically efficient by the trained coöperative work which in the highest degree the military conditions afforded?

In conclusion, may I not say that the highest service which war surgery shall have rendered civil practice will be to have perpetuated this same spirit among these men as they return to their various fields of daily life?

GENERAL CONSIDERATIONS AS TO THE TREATMENT OF WAR WOUNDS

By ANTOINE DEPAGE, M.D.
BRUSSELS, BELGIUM

Among the important scientific contributions which have been produced in the course of this war, those which pertain to surgery have been, perhaps, the most characteristic and the most productive of important results. They have impressed upon the treatment of wounds a new evolution which will make an epoch in surgery.

Observation has shown us in the first place, contrary to what had seemed to be established by previous wars, that in the great majority of cases wounds are infected, or, at least, contaminated. In consequence of this first dictum débridement became to all surgeons a formal indication of the first rank. In general, all wounds inflicted by war fragments or from grenades, as well as the wounds by shrapnel or of bullets, which produced serious lacerations in the interior of the tissues or were accompanied by an abundant bloody effusion were freely opened up immediately upon the arrival of the wounded at a hospital organization sufficiently equipped. At the same time the contused and lacerated tissues which constituted a medium favorable for microbic growth were cut away with the greatest care so that there was effected a veritable *épluchage* of the wound before proceeding to its dressing.

As a complement to this surgical intervention, surgeons had recourse for a while in grave cases to cauterization by the thermocautery, or by superheated air or by the application of a chemical.

These various agents, however, were given up because of their unduly violent action.

Since January, 1915, we have followed at l'Ambulance de l'Ocean débridement and épluchage, with primary suture, when the cases appeared to us favorable, or we have resorted to secondary suture, as soon after their dressing as the surfaces of the wound appeared to be clinically aseptic, although we did not possess at that time any formal index as to the evolution of the microbian flora in a wound, so that it was not possible for us then to build up a systematic method of procedure. The merit of having systematized scientifically the secondary suture of wounds belongs to Alexis Carrel, who at the beginning of the war put himself at the disposition of the *Service de Santé* of the French Army and was put in control at Compiègne of an experimental clinic of 80 beds. With the help of the chemist Dakin, Carrel sought for an agent capable of destroying the microorganisms in the depths of wounds, more efficient than any of the agents which had up to that time been recommended.

After a very minute study made by Dakin as to the relative value of a large number of antiseptic agents, Carrel chose the hypochlorite of soda which even in dilute solution has the great property of conserving the proteins and of preserving also its antiseptic power in the presence of blood serum and organic exudates. The great inconvenience of the sodium hypochlorite was its caustic action upon the tissues and particularly upon the skin. Dakin remedied this by preparing a solution of the hypochlorite of a determined strength perfectly steady and by neutralizing it with boric acid.

I need not detail here the preparation of the Dakin solution. I will dwell only upon two points.

1. The solution must be fresh, prepared from day to day.

2. Careful verification must be made as to its reaction and all preparations must be rejected which are not absolutely neutral.

But the method of Carrel does not consist alone in the choice of the solution of Dakin for the irrigation of wounds. The way in

which this solution is employed constitutes an essential point of the method. The different steps of the method as finally used by us may be stated as follows:

1. Beginning with the admission of the patient in the hospital, the injured region is shaved and washed carefully with a neutral solution of oleate of soda.

2. Débridement and *épluchage* of the wound are practised immediately thereafter.

3. At the same time are installed the Carrel tubes which are introduced to the bottom of the wound in such fashion as to permit the irrigation of the entire wound surface.

4. Application to the entire surroundings of the wound of compresses smeared with vaselin in order to prevent irritation of the skin.

5. Dressing with compresses of absorbent material.

6. After the return of the patient to bed, the Carrel tubes are connected up with the receptacle containing the Dakin solution and irrigation is carried on every two hours, controlled by a simple pressure forceps of Mohr.

7. The dressings are renewed every day, and in the course of each one of them, careful lavage of the wound is made with oleate of soda. One must not permit to remain upon the skin about the wound the slightest concretion, for such always hide colonies of microbes.

However, it was not possible for us to judge the method of Carrel at its true value and to derive from it all its benefits until we were able to follow the evolution of the wound by methods of bacteriological control.

This control was a most valuable element in the method of Carrel. It consists in the regular determination of the abundance of the microörganisms in the wound exudates.

To carry it out there is made a simple smear according to the usual laboratory methods, in which are counted the number of microbes contained in the microscopic field. This bacteriological control was established in a systematic way in our hospital from the beginning of June, 1916. Every two days it was repeated in

the same wound. At one time it was being applied in more than 500 patients at a time. For the purpose of being able to follow at a glance the progress of infection in a wound, we have made tracings of the microbic strength. We have made use for this purpose of charts of a special model, resembling temperature charts.

In a general way the microbic curve followed a characteristic line. On the entry of the patient in the hospital, or when the wound had just been opened up, the chart indicates in the majority of cases no microbes. At this time the wound is only contaminated, and the infection has not spread over its whole surface. On the second day the chart shows a sharp ascent in the microbic growth and holds itself at high level for some days. In severe infections there may be counted 100, 200, even 1000 microörganisms in a visual field. The line undergoes afterward more or less oscillations, the progress being more or less downward until the zero point is arrived at after the lapse of a variable time according to the character of the lesion or the nature of the infection.

Sometimes the wound is maintained sterile from the first day, the microbic track following the horizontal line to zero.

The infected wounds were rendered sterile by the Carrel treatment in from six to eight days.

Other solutions recommended for the same purpose gave in general a sterilization more slow and less certain. Certain agents, as flavine, seemed to produce a rapid sterilization in a way more efficient than the Carrel, but generally the results were not stable in their sterilizing power, because they disturbed the granulation of the wound and favored secondary infection.

In the cases of infected fractures the line descended permanently to zero, only after fifteen days to one month. Osseous wounds were sterilized moreover with difficulty. It was the same also with articular wounds. Whenever a sequestrum was present, it was necessary to take it away before definitive sterilization of the wound could be obtained.

The wounds which were soiled and irregular were sterilized

more slowly than simple wounds. The bacillus perfrigens (gas bacillus) and in general all microbes producing gaseous gangrene did not alter the course of the curve. These microörganisms disappeared rapidly from the wound whenever it was freely opened up and freely pared. Staphylococcus persisted longer. In cases of staphyloocccus infection the zero point was arrived at very slowly and very often the infection persisted notwithstanding the treatment.

In fact, bacteriological evolutions in a wound may be considered in three periods:

1. The period of acute infection of variable duration in course of which the microbes are very numerous and present a maximum degree of virulence.

2. The period of attenuated infection during which the curve follows a descending course and corresponds to an attenuation of the microbian virulence.

3. The period of sterilization which is indicated at a line horizontal with zero.

Our collaborator Govaerts has shown that these three periods of microbic infection correspond to three periods in the organic reaction of tissues.

1. During the period of acute infection there are then only polynuclear elements in the wound exudate.

2. In the later course of the microbic disease the polynuclear elements disappear and there are found in the preparation mononuclear elements which become more and more numerous. At the end of this period macrophagi begin to appear.

3. In the course of the period of sterilization there exists in the preparation the macrophagi.

Evidently we do not attribute to the microbic curve an absolute value, but in the majority of cases its practical value is the real one, for it permits us to follow the evolution of the infection in the wound and indicates the moment when suture may be practised with the greatest probability of success.

Experience has shown us, nevertheless, that it is necessary to take into account in deciding the moment of suture, not only the

quantity of infectious agents present, but their quality, and from this point of view was recognized:

1. That wounds slightly or moderately infected by ordinary microbes may be sutured without danger and with every chance of success.

2. That the presence of staphylococci does not contra-indicate suture.

3. That the perfringens remain enclosed in the wounds only a very short time, but as long as these microbes do not disappear it is dangerous to resort to suture.

4. That a wound should not be sutured when there was even a slight streptococcic infection.

For the purpose of specifying more exactly the microbic flora of the wound and of determining better the moment most favorable for suture, we have thought it useful to supplement the counting of the microbes upon the smears subjected to bacteriological examination by cultures instituted regularly after the débridement and before the suture. We have to this end adopted a more complete microbic chart, proposed by Dr. Levaditi of the Pasteur Institute, who has devoted himself especially with us to the study of the infection of wounds.

The conclusions as to suture up to the present moment have been as follows:

(*a*) For wounds feebly infected from the first day with ordinary microbes proceeds to suture when at the second examination the smear yields only one microbe in a visual field.

(*b*) For wounds strongly infected by ordinary microbes, resort to suture from the moment when the curve comes down to one microbe in four fields.

(*c*) For streptococcic infection never to suture but to submit the wound to adequate treatment, preferably that of Carrel, and to wait until the streptococci have disappeared, or have become attenuated sufficiently to permit primary union.

Streptococcic vaccination may render here the greatest service. The researches made in our hospital by Dr. Levaditi leave no doubt on this point.

Such, gentlemen, are the most important general rules which in our opinion should guide us today in the treatment of war wounds, and which have as their object the production of a sterilization of the wound sufficiently complete to make successful suture possible.

Immediate Primary Suture. Immediate primary suture may be made immediately after débridement or it may be made from two to four days after débridement.

Delayed Primary Suture or Early Secondary Suture. In this latter case it is done as is primary suture, without refreshing of the wound surfaces by simply approximating the surfaces. Finally, the suture may be made in the course of the granulation of the wound when sterilization has been sufficiently assured.

Secondary Suture. This always necessitates the refreshing of the wound surfaces by which step it is distinguished from the preceding methods of suture.

The immediate suture is indicated in cases where the clinical aspect of the wound after débridement and épluchage gives a guarantee of sufficient sterilization. It may be resorted to especially:

1. In wounds of joints, and in general, in wounds of serous cavities.

2. In wounds of the cranium, of the face, of the hand and of the foot, where the abundance of vascularization, both blood and lymph, warrants a surgeon in making immediate suture as a rule.

3. In superficial wounds of the soft tissues in certain fractures without comminution. This suture has the advantage of offering anatomical repair of the tissues, but infections, when they take place, are always rapid and grave, involving diffuse phlegmonous and gaseous gangrene.

Late Primary Suture or Early Secondary Suture. Late primary suture or early secondary suture is indicated particularly for wounds involving soft tissues only and for some open fractures. It is done after bacteriological control has been made as described above. Late primary suture rarely fails of success on account of grave accidents.

Late Secondary Suture. Late secondary suture is reserved for wounds which cannot be sutured during the first days, because of too extensive destruction of tissue, or because of the development of infection. It offers the great advantage of giving complete security, but it delays the healing and does not always give as perfect an anatomical restitution as the other forms of suture.

There remains now for examination the problem of the treatment of war wounds from more special points of view, and of considering the peculiarities which arise from the organ or the tissue wounded.

We shall examine in succession:

Wounds of the cranium.
Wounds of the face, of the hand and the foot.
Wounds of the soft tissues.
Amputation stump wounds, fractures.
Joint wounds.
Wounds of the chest.
Abdominal wounds.

We shall limit our discussion to general indications.

Wounds of the Cranium and of the Hairy Scalp. When we have to deal with a wound of the hairy scalp, limited to the soft parts, we cut away the margins of the contused surface and suture them immediately. When the cranium is wounded without an opening in the meninges, we practice regularly trephining in order to take away the fragments in the internal table which are practically always present and, as in the case of wounds involving only the hairy scalp, we finish with immediate suture.

When a wound of the brain has taken place two complications are feared: (1) Cerebral hernia. (2) Meningo-encephalitis, that is to say, infection of the meningo-encephalic spaces.

The hernia is the result of the edematous and blood congestion of the cerebral substances during the first hours which follow the traumatism. It corresponds to the swelling of the external features in wounds of the face, but with this special feature that encephalic congestion drives to some degree the cerebral contents

out from the cranial box. Once established, the cerebral hernia invites infection and favors its development by the spaces which are created beneath it and which it is impossible to keep aseptic. We find ourselves then always in the presence of a vicious circle, the continuity of which it is often difficult to break.

Therefore, in treating a wound infection the surgeon should always seek to hinder the production of the hernia. Dressings which produce compression are from this point of view indispensable above all on the first days.

The ideal treatment consists without doubt of disinfection at a single sitting of all cerebral lesions and in immediate closure of the wound, but the experience at our hospital has been that wounds of the brain are contaminated or infected by the projectile in the proportion of 55 to 60 per cent., and that it is not possible to render them sufficiently aseptic at a single seance by any means at our disposal. Therefore, the immediate closure of the cranial breach has been attended with danger in a number of cases.

In determining the course it is necessary to be guided by the microbic curve and to resort either to late primary suture or to early secondary, or to secondary suture more or less late, if a sterilization is more or less late in being accomplished.

Wounds of the Face. Wounds of the face have this in particular, that they involve vascular regions not favorable to the development of gaseous gangrene and to infection in general; they may with all certainty be brought together by immediate suture in most cases. Moreover, the retractions which inevitably follow in a wound of the face left open for a certain time often prevent apposition of the skin when a secondary suture is made and produce deformities more or less marked. It is then a matter of importance to close wounds of the face as early as possible.

When the lesion is superficial and the soft tissues alone are involved, cutaneous flaps may be formed and the suture definitely accomplished at the same seance. Complicating fractures of the jaw do not constitute an obstacle to the immediate suture. The

specialist may generally succeed in manipulating through the reconstituted buccal cavity the prosthetic apparatus which is necessary to hold the fragments in coaptation. If the mass of the face is widely destroyed, the skin should be brought over it as far as possible so as to prevent retraction, and esthetic repair of the face should be accomplished later by rhinoplasty, cheiloplasty, or other autoplastic processes.

Wounds of the Hand and of the Foot. It is important here, likewise, to suture the wounds as early as possible in order to prevent retractions and to lessen the losses of functional power which may follow. But though immediate reunion may practically be possible in all superficial wounds where they are limited to the hand and to the foot, it is not always so when the destructions of tissue have been great. Infection in these cases is often difficult to overcome because of the multiplicity of the cellular spaces and the complexity of the joint cavities which often connect with each other. To secure their sterilization it is necessary to widely open the wound throughout its whole extent, and for this purpose resection and wide arthrotomies are often indispensable.

We have operated during the period from June, 1916, to November, 1917, on 523 wounds of head, face, foot and hand which have resulted as follows:

		Per cent.
(*a*)	491 immediate sutures which have given:	
	473 complete successes, viz.	96.3
	8 partial successes, viz.	1.6
	10 failures, viz.	2.1
(*b*)	18 late primary sutures which have given:	
	18 complete successes, viz.	100.0
(*c*)	64 secondary sutures which have given:	
	58 complete successes, viz.	90.6
	4 partial successes, viz.	6.2
	2 failures, viz.	3.2

Wounds of the Soft Tissues. Superficial wounds of the soft tissues lend themselves generally well to immediate suture, and according to the more or less large extent with which the processes of débridement and épluchage have been resorted to we

may determine the indications of the wounds in a large measure. It would be dangerous, however, to go to too great an extent in this direction, for immediate suture does not permit any bacteriological control, and very often the perfringens bacillus and the streptococcus are there, only awaiting a favorable occasion for their development.

One should not lose sight of the fact that in delaying the suture in order to permit of a preliminary bacteriological examination one does not practically prevent the healing. If, in fact, the wound is sterile at the beginning, the microbic test will show it and one can practice the late primary suture on the second, third, or fourth day, with every certainty of success. If, on the contrary, infection persists after the débridement and the épluchage of the wound, it has been to the interest of the wounded man that the microbic curve has been established and that the suture should be done secondarily after sufficient sterilization.

However, it may be accepted as a general rule that primary suture of a wound should not be the rule:

(*a*) When the lesion dates back more than eight hours.

(*b*) When the patient has been already subjected to previous surgical examination.

(*c*) When the lesions involve deeply the muscular masses and when the tissues are much soiled and lacerated.

As we have seen, secondary suture is done by bringing the margins together after refreshing and removal of the cicatricial film. The granulations are left in place; they do not hinder the union by first intention.

When the wound is irregular, in certain cases the irregularities may be overcome by dissecting the granulations without and within, so as to turn them over upon themselves. Moreover, the muscles may be dissected and sutured to their fellows. Care should always be taken to suture the aponeuroses in order to prevent later muscular hernias. If very strong tension of the skin is present, it is necessary to make more or less extensive slidings thereof. Sometimes one must proceed to a cutaneous débridement. Quite often we have had recourse to grafts after

the Italian method, or epidermic grafts, or often to the "greffe en culbute," which consists in cutting the cutaneous flap at a distance more or less great from the wound and bringing it to the wound by successive steps, turning it over upon itself.

The number of wounds of the soft tissues which have been treated during the period from the month of June, 1916, to the month of November, 1917, has been 1447, the outcome of which has been as follows:

	Per cent.
(*a*) 380 immediate sutures with:	
317 complete successes, viz.	83.9
24 partial successes, viz.	6.3
39 failures, viz.	10.2
(*b*) 222 late primary sutures with:	
207 complete successes, viz.	93.2
8 partial successes, viz.	3.6
7 failures, viz.	3.2
(*c*) 845 secondary sutures with:	
724 complete successes, viz.	85.6
70 partial successes, viz.	8.0
51 failures, viz.	6.4

Amputation of Stump Wounds. When a surgeon amputates a limb, he should never forget that the stump is to support later an artificial limb. This is so often lost sight of in the course of amputations that I feel that I should insist upon its importance. The surgeon uses all his skill in fashioning a fine flap which carries the suture line upon the side, but he takes no account of the length of the arm for leverage to which an apparatus may be fitted. The immediate operative result occupies his mind only, while he leaves to the orthopedist the care of the prosthesis without troubling himself with the importance that he should furnish to the latter a stump easy to equip.

It is, nevertheless, proper to remark that formerly the bearing of prosthetic appliances was at the end of the stump, and that therefore a lateral scar had its reason for being, but most modern apparatus take their point of bearing over the whole surface of the stump and leave the extremity free from any contact whatever. The result is that the apparatus now used are more appropriate

for a terminal cicatrix than for a lateral cicatrix, and that they may often be put in place before cicatrization is entirely completed. Adherent scars when they are terminal do not otherwise constitute an obstacle to the prosthesis, and in making the decision it is always the length of the arm of the lever which should take precedence over the qualities of the cicatrix.

From another standpoint we formulate three essential considerations which should cause us to reject primary suture in a great number of cases of amputations for war wounds.

(*a*) It is necessary to act quickly and to seek first, above all, to save the wounded man's life.

(*b*) Primary union is difficult to secure. The stump wound being generally infected, its immediate closure is sure to produce great complications.

(*c*) It is necessary to amputate as low as possible, often through a traumatized area, in order to leave the bone as long as possible.

Guillotine Amputations. Guillotine amputations are from this point of view the most favorable. They give, after repair of the stump, a lever arm longer than amputations after primary suture with a flap, the fact being that such suture rarely succeeds and if done it is necessary to intervene a second time.

We have made since June, 1916, to November, 1917, 31 secondary sutures after amputation which have given 26 complete successes, 4 partial successes, and 1 failure.

Open Fractures of the Long Bones. The objective toward which we direct the surgical treatment of open fractures apart from the orthopedic treatment, is the transformation of an open fracture into a closed fracture. To this end:

(*a*) Musket-ball fractures with through and through wounds, with small orifice of entry and of exit, without swelling and without lesion of the great bloodvessels, are treated aseptically and are simply immobilized in an apparatus with extension. The patient is watched closely for the first week and if accidents of infection develop, the fracture is operated upon.

(*b*) Other fractures are operated upon at once. The wound is opened up by an incision sufficiently wide to permit of a deep

exploration of the entire wound area surrounding the fracture; at the same time excision of the lacerated soft parts and extraction of foreign bodies is accomplished. Free bony fragments are taken away with care, pointed bone ends which threaten the vessels and the nerves are resected, but care should be taken to preserve as far as possible a bony bridge between the fragments in order to favor consolidation.

The wound is then sutured immediately either by late primary suture or by secondary suture according to the seat and extension of the lesion and the gravity of the infection.

Immediate suture is attempted only in very exceptional cases which present a minimum of soft tissue, as the humerus and forearm. It is never practised in the course of an offensive and is contra-indicated in wounds of the soft tissues when the wound dates back more than eight hours, or if a wound cannot be kept under the same surgical oversight.

Primary delayed suture or early secondary suture is practised when the microbic curve present shows a sufficient sterilization from the beginning of the treatment.

Late secondary suture is the most frequently resorted to. It may be used as soon as the Carrel treatment has obtained the clinical sterilization of the lesion, that is to say, from fifteen days to a month, unless the infection has been due to streptococci. In the event of this last accident, suture may be delayed for several months.

The treatment which we have just sketched and which consists in transforming the open fracture into the closed fracture shortens the time necessary for cure and guards the patient from the complications produced by prolonged immobilization.

We resort to amputation in case of fracture only in extreme cases. Experience has shown us that one can by careful application of the method of Carrel preserve limbs which in former times would have been considered irremediably lost.

The number of fractures operated in our service from May, 1916, to November, 1917, has been 191, divided as follows:

(*a*) Fractures of the femur, 43, of which there were 4 primary sutures with 4 cures, viz., 100 per cent.

	Per cent.
Under delayed primary suture:	
39 secondary sutures which gave:	
30 complete cures, viz.	76.9
7 partial successes, viz.	17.9
2 failures, viz.	5.2
(*b*) 148 fractures of other bones:	
26 primary sutures with:	
20 complete cures, viz.	76.9
3 partial successes, viz.	11.4
3 failures, viz.	11.34
20 delayed primary sutures with:	
16 complete successes, viz.	80.0
4 partial successes, viz.	20.0
102 secondary sutures with:	
92 complete successes, viz.	90.0
3 partial successes, viz.	3.0
7 failures, viz.	7.0

Joint Wounds. Under the head of joint wounds, we simply include those of the large joints, as of the knee, of the hip, of the elbow, and of the shoulder. In general, an articulation kept open becomes infected notwithstanding the most daily care. On the other hand, the immobilization to which the limb is subjected, added to the constant irritation of the joint surfaces by the secretions with which they are bathed, determines the presence of adhesions and ankyloses.

During the first period extending from December 20, 1914, to September 10, 1915, we treated joint wounds by the system then in use everywhere, which consisted in the drainage of the cavity, the dressings being renewed several times a day, at each of the dressings to irrigate with an antiseptic solution, such as oxygenated water, formalin water, carbolated water, etc. The limb was immobilized either by means of an interrupted apparatus (bridged) or by means of a gutter. The results were frankly bad. At this time the wounds of the knee-joint were considered as the gravest in character in war surgery.

During a second period, extending from December 10, 1915,

to July 1, 1916, we applied the method of Carrel after débridement of the wound. The results were a distinct improvement over those of the first period, but they were still not very brilliant. They demonstrated to us, especially for the knee, that the method of Carrel was not sufficient to make certain in a dependable manner the practical sterilization of a joint cavity.

Since the month of July, 1916, we have resorted to wide arthrotomies with immediate closure of the joint whenever possible.

From the month of May, 1916, to the month of November, 1917, we made:

(*a*) Sixty-six immediate sutures for wounds of the large joints without bony lesion. Of these there were 62 cures, viz., 95.7 per cent.; 4 failures, viz., 6.1 per cent.

(*b*) Seventy-nine immediate sutures for wounds of the large joints, with bony lesions. Of these there were 71 complete successes, viz., 89.8 per cent.; 1 partial success, viz., 1.2 per cent.; 7 failures, viz., 7.0 per cent.

These results show indisputably the superiority of immediate suture after wide arthrotomy, closing of the joint cavity, over any other method of treatment. It is necessary, however, not to lose sight of the fact that conditions do not always favor a primary suture at the elbow and at the shoulder. In wounds of these regions, in fact, the soft tissues are often so torn that it is impossible in many cases to secure apposition in the wound borders. The Carrel treatment followed by secondary suture or by cicatrization by second intention is evidently indicated in such cases.

On the other hand, the results of resections are not the same for the elbow and the shoulder-joints, as for the knee-joint. In the two first, resection results in articular mobility, while in resecting the knee the movements of the joint are in great measure destroyed. Therefore, for the shoulder and the elbow, one easily decides to do a resection, when one shuns it at all hazards in cases involving the knee. Aside from cases in which there was a simple through and through wound with minute orifices which healed spontaneously, the treatment of choice of numerous war

wounds involving a joint consists in a wide opening of the joint, a careful cleansing of the cavity, curettage of the osseous surfaces, if they are injured, and the immediate suture of the wound, with or without drainage. Immobilization is de rigueur from six to eight days.

The Carrel treatment is indicated in joint wounds with extensive lesions of the soft tissues which do not allow approximation of the skin, which is often the case at the elbow and at the shoulder. However, in these cases the attempt may be made to close the fracture primarily by means of a sliding of skin or by an autoplasty. Finally, a resection is justified in extensive lesions of the bony ends, but it is necessary not to lose sight of the fact that typical resection, particularly at the elbow and at the shoulder, promises better results from the point of view of function that an incomplete operation leaving an osseous callus at the lower part of the articular cavity.

There remain, then, two questions for consideration with regard to joint wounds:

1. When a purulent infection of an articulation has taken place, how should it be treated?

2. Joint resection having been judged necessary, is it necessary to follow it with primary suture, or is it better to resort to secondary suture?

1. The first question has been answered by Dr. Willems who, cutting loose from ancient prejudices, has replaced immobilization by active mobilization. The movements to which a joint is subjected when they are executed by the patient are not painful, and the results produced by this mode of treatment are really remarkable. The suppuration diminishes rapidly and infection disappears and the joint mobility is preserved, even when infection has been profound, with relatively considerable tissue destruction. It is proper to remark, however, that the mobility can give its full return only when its application is watched over by a competent surgeon.

2. As to whether it is better after articular resection for a war wound to make primary suture or secondary suture, the con-

ditions will vary according to the joint affected. For the elbow and the shoulder, as a rule, it is better to make immediate suture to the end of preserving movement, but as our experience has demonstrated, such a result can rarely be realized. In a large number of cases we have had to resort to secondary suture, or often to permit the wound to heal by secondary intervention.

After resections of the hip and especially after those of the knee, primary suture is dangerous. On account of the impending infection, it is better to leave the wound open, to keep the bony surfaces separated by apparatus, to sterilize the wound according to the method of Carrel and to complete the surgical treatment by secondary suture.

Chest Wounds. Taking up next the question of the closure of penetrating wounds of the chest, that is to say, open pneumothorax. When the thorax is opened, the air rushes into the pleural cavity and the lung contracts upon itself with the result that there is a disturbance of the respiratory equilibrium which may go on even to asphyxia, syncope, and finally death. Generally, however, the respiration becomes reëstablished and regular after a certain time through the coöperation of the lung on the sound side. The lung on the wounded side remains contracted in a state of collapse; after a time it loses its elasticity and becomes fixed after a fashion in its new position.

As the result of the inflammatory reaction of the pleura, there is formed a fibrinous layer more or less thick, which encloses the lung and is the source of the impossibility of the lung undergoing physiological expansion. There is thus established between the lung and the parietes a separate cavity which necessarily persists as long as the lung cannot be brought into apposition with the thoracic wall. In order to accomplish this have been advised the operations of Estlander, of Schede, of Delorme, and the one which we ourselves have recommended to depress the wall of the thorax by a massive resection of the costal wall.

The general considerations that we have just stated show how important it is to close the thorax immediately after the wounding. The rules which have been adopted by us at our hospital are

based essentially upon the idea of securing the suture of the parietes. They are as follows:

1. If the thorax is widely opened and the lesions recent, and there is persistent hemorrhage from the lung, the indication is to apply hemostatic suture to that organ, although if the flow of blood is very abundant and the condition of the wounded man is very threatening a tamponade of the pulmonary wound must be resorted to. In order to close the pleural cavity if it is not possible to close the thorax breach by reason of its extent or because of the menace of infection, we apply a special tampon that we have designed which we call "*tamponnement en bouton de chemise*" (shirt-button tampon), which makes certain the hermetic sealing of the cavity at the same time that it permits drainage.

The use of local anesthesia in the course of intervention and in the later dressings is most useful.

2. If the orifice is narrow but still permits the air to enter, it is necessary as soon as possible to obtain its secure closure in order to stop the progress of the pneumothorax. It should be well understood, however, that, in cases of hemorrhage of the lung a preliminary enlargement of the pleural opening may be necessary in order to treat the pulmonary wound. Occlusion of the thoracic wall is accomplished by the suture *en masse* of the musculocutaneous planes.

3. If there is present an open pneumothorax, with an already developed pleural infection, the treatment of Carrel is instituted in all cases, and as soon as sterilization of the wound has been accomplished the cavity is closed by suture in the musculocutaneous spaces.

Before proceeding to closure it is indispensable to control the sterilization of the pleura by cultures from the exudate. It is necessary, moreover, that the pleural secretion should have become completely dried up. It is only in these conditions that operation may have any chance of success and that it will replace definitely all those methods of intervention, which in order to bring the lung and the parietes into apposition demand more or less resection of the costal wall.

Wounds of the Abdomen. In order to complete our report, we should now speak of suture of the wounds of the abdomen, but such general accord has been established that all surgeons think that early intervention should be resorted to. For the end of permitting us to intervene as early as possible in abdominal lesions, lesions of the thorax, or in cases of severe hemorrhage, we established at a distance of 2 or 3 kilometres from the front, advanced dressing stations sufficiently well equipped to make possible interventions of urgency. The installation of these posts reduced the mortality in wounds of the abdomen from 65 per cent. to 45 per cent.

THE MOST IMPORTANT FACTOR IN THE TREATMENT OF WAR WOUNDS AND THE MOST IMPORTANT FACTOR IN CIVILIAN SURGERY—THE GOOD SURGEON.

By GEORGE W. CRILE, M.D.
CLEVELAND, OHIO

The surgeons and the pathologists who for four years have intensively studied war wounds have formulated many theories of treatment—many apparently contradictory theories. Thus there have been presented the claims of the value of various chemical agents against those of no chemical agent; of moist dressings against dry; of heat against cold; of frequent dressings against infrequent, and of no dressings against both; of sunlight and of electric light against occlusions; of immersion against hot air; of bacteriological control against clinical judgment; of vaccines, toxins and foreign proteins against normal reaction; of wound inoculation with harmless organisms against wound sterilization; of isotonic against hypertonic solutions; paste has competed with paste; bipp with ip; sap with both; and chromic pastes with all.

Does not this intensive study of infection in war wounds for this comparatively short period equal and recapitulate the more leisurely study of infection during the thirty years since Lister first proposed the carbolic spray? And is there not emerging from the present conflict of opinions the same fact as that which emerged from the post-Listerian period—that the one agent of successful surgery, whether war surgery or civil surgery, is *the good surgeon?*

In civil surgery here in America, by what agency was mastery achieved over appendicitis, over cholecystitis, over tubal infec-

tion, over adenitis? What agent has contributed the most to the success of resection of the intestines and of the stomach; of gastro-enterostomy; of treatment of suppurating stone in the kidney; of treatment of infection of subcutaneous tissue? What agencies have achieved survival? One and but one—*the sound surgeon*, who always creates opportunity. Is it possible that in these four intense years of war surgery, in which more experience in traumatic surgery has been accumulated than during the past thirty years, we have traveled around the same circle as in civil surgery and have again found the same surgeon?

By sound surgery we mean the assumption of complete inclusive responsibility for every item that enters into the result; the consideration of the wound as well as the patient; the development of an ability to read the wound as well as the man aright. Sound surgery means quick, innocuous, timely intervention; it means seeing clearly the tomorrow of the wound; it means no intervention unless there is to be a net gain; it means a sharp knife, a good anesthetic, a painless innocuous dressing; it means as much respect for the tissues of the anesthetized man as those of the unanesthetized man; it means a training in judgment that unerringly tells when to cut, how far to cut, when to quit cutting. It plays all the defences and reparative forces of the patient. Good surgery is the exponent of no single method. It recognizes the anatomical and environmental situations in which chemical and physical agencies are useful. Good surgery exploits physiological rest and fluids and sleep; it gives little pain. Good surgery evokes confidence; and confidence begets rest; and rest begets restoration. Good surgery, then, makes use of antiseptics and physical forces, just as it uses incisions, counter-drainage, revisions, skin-grafting, blood transfusion. Good surgery does not substitute an easy formula for its principles; above all, it always is dissatisfied with its work and always is open to suggestion.

What could the good surgeon accomplish with the wounds of war, with good opportunity but no antiseptics? Without antiseptics he could close by primary union a higher percentage of contaminated wounds than with antiseptics; he was able to remove damaged tissue with such accuracy that the natural

defences of the revised wound became its best antiseptic; he closed penetrated knee-joints more securely without than with antiseptics; he closed penetrated skulls without better than with antiseptics; he operated on perforated intestines more successfully without than with antiseptics; he cleared up foul and infected superficial wounds as well without as with antiseptics; he met gas gangrene with the timely use of the knife as well without as with chemical agents. He closed healthy superficial wounds with early suture tied lightly; healthy wounds that could not be closed by suture he closed by skin grafting both as a healing and as a bactericidal policy; he closed fecal and urinary fistulæ without antiseptics.

On the other hand, he realized equally that in compound fractures with or without bone infection, in deep, recessed wounds, in pyocyaneous infection, in many other types of wound, that antiseptics might have great advantages, and he used them and used them well. In certain phases of a wound he would use Carrel-Dakin; in another, acetic acid; in another, hot pack; in another, incision—a physiological incision today to avoid the tissue tension of tomorrow; in another transfusion; in another, sunlight or electric light; in another, continuous alcohol to make a scar covering.

In the rush of a great battle he incised for drainage, and in addition he made "physiological incisions" to avoid the tension that is sure to follow the next day from the inevitable infection.

But in quiet times, with microscopic exactness, he dissected out every atom of devitalized tissue. He read accurately not only the wound, but the patient; not only the patient, but the military situation; not only the military situation, but the condition of the infecting soil, the state of transport, his surgical assistance and the type of nursing care—that is, he weighed accurately his chances for success. Therefore, the army medical service and the wounded man pinned their hope and their faith first, last and always to the one agency of wound treatment that in civilian surgery emerged clearly from the confusion of the Listerian period; emerged clearly from the confusion of the four years of military surgery—the sane, sound surgeon.

THE PROBLEM OF THE "SLIGHTLY WOUNDED" IN MILITARY AND CIVILIAN PRACTICE

By WILLIAM E. LOWER, M.D.
CLEVELAND, OHIO

Everyone who has had the high privilege of participating in the World War must now be deeply concerned with a consideration of the way in which the lessons acquired in that vast experience may be adopted to the needs of civilian life. For the medical officers in particular the war has supplied a postgraduate course of untold magnitude in organization, in transportation, in sanitation, in hospital construction, in the management of supplies, in the treatment of every variety and kind of wound by every variety of method, and, perhaps most important of all, in noting what not to do.

Among the infinite problems met by the medical officer in his experience both at the Front and at the Base Hospital one of the most pressing was that presented by the slightly wounded man—the "walking wounded."

In rush periods, when large numbers of seriously wounded cases demanded the immediate attention of the medical officers and attendants, there was an inevitable tendency to neglect the still larger number of slightly wounded, or at the best to leave them to the attention of the comparatively untrained men, the most expert judgment being engaged with the apparently more urgent problems of the more serious cases.

This seemingly unavoidable neglect of the slightly wounded, however, proved to be a dangerous hazard to the available man power and rapidly thinned the front line in certain periods of

the war. The seriously wounded could be of no further service in the trenches, and it became of the greatest strategic importance that the slightly wounded should be returned to the line in the shortest possible time. Yet because of the pressure of numbers and the lack of early expert care, thousands of men with slight injuries became seriously infected and many died or were permanently disabled. The time factor in these cases was of supreme importance, and cases which under proper care could have been returned to the line within three weeks were disabled for three months or more. The only way this could have been avoided would have been to have the seriously wounded and the slightly wounded treated by separate organizations, for the natural thing was to care for the more seriously wounded first. If the slightly wounded had been sent where the attention of the organization was on the treatment of their cases only, much better results would have been obtained.

While it is true that the results of neglect of the "slightly wounded" in civilian practice cannot be computed on so gigantic a scale, nevertheless if all cases of apparently trivial industrial accidents which become infected as the result either of neglect on the part of the patient to report promptly or because of inefficient treatment could be paraded annually, the size of this army of civilian disabled would be startling in the extreme. As they cannot be thus displayed, and only isolated cases are noted, no special impression has been made, and the consequent loss of life and limb and the economic loss to the community goes on unchecked.

This is more true of the smaller than of the larger industrial centers, for the larger industries appreciate the value of the time loss of their employees and are constantly striving for a more efficient medical organization. Many of the great industrial plants have splendidly equipped medical departments, under able advisors, in which thousands of cases are treated annually. As a result, these plants report an extremely small percentage of cases of infection which came from minor injuries. The greater number of calamities among the industrial wounded

occur in the smaller centers, where there is no organized plan to provide proper care or where the surgical attendance is given by men of limited experience.

What may be accomplished by proper organization is well illustrated by the reports from a number of centers to which inquiries had been sent in the preparation of this paper. Dr. Sherman, chief surgeon of the Carnegie Steel Company, reported as follows:

"The percentage of slight wounds which go on to serious involvement is almost *nil* when the patients report within a reasonable length of time for first-aid treatment at our emergency hospitals. Before these hospitals were properly organized and equipped the percentage of infection varied considerably; at none of our plants was there less than 5 per cent. of the open wounds infected, while in some the percentage ran as high as 50. The reason for this was faulty organization and carelessness on the part of doctors and nurses. As a result of our campaign of education among our employees to report immediately for all minor accidents regardless of their nature, we have had very few serious involvements which have been due to accident. We have found that the ratio of infection where the patients receive early first aid average 1 to 700. The vast majority of our cases that are infected come to us infected as a result of delay in reporting.

"Investigation of this subject will reveal the fact that much of the infection is due to lack of coöperation of the large industries and the medical profession and the failure on the part of the latter to carry into practice in all its detail the same up-to-date surgical technic that is carried out in the average operating room. One would think that such a simple procedure as the aseptic and antiseptic treatment of simple wounds would be too primitive to permit of discussion, nevertheless, nine out of every ten doctors are very negligent in the treatment of these conditions."

It is not only in industrial plants, however, that we meet the problems of the "slightly wounded" in civilian life, for many of our hospitals pay too little attention to the problem of minor injuries, and such cases are too often turned over to untrained

and inexperienced persons, the interns always being more interested in the major operations and wounds.

The economic and the ethical importance of the proper care of punctured, incised or lacerated wounds, practically all of which are contaminated and likely to become infected, has not been sufficiently emphasized. There is still too great a tendency to close such wounds primarily without proper cleansing rather than to leave them open and suture secondarily if the wound cannot be correctly disinfected at once. The war has definitely demonstrated that practically all these slight wounds can be sterilized, however, and then closed primarily, and in civil practice, when these cases can be seen early, almost 100 per cent. can be so treated.

This principle applies not only to the accident ward but to the operating theater as well, where the too frequent catastrophes following the so-called "slight" or "minor" operations testify to the neglect of some radical factor in proper treatment, due to improper teaching and instruction. In the great majority of hospitals "major" operations are most carefully governed by proper precautions. The operators are prepared for the possible emergency; an experienced, trained anesthetist is employed and the principles of asepsis are rigidly observed. But the "minor" operations are too often undertaken by untrained and inexperienced men without proper guidance, regardless of the ever-present dangers of improper anesthesia, of infection, of functional impairment; and the calamitous end-results are out of all proportion to the small percentage of such results which could occur if every possible precaution were taken. Many practitioners who are not trained for surgery are influenced by their patients who request surgical attention for some minor ailment, as they are not willing to suffer what seems to them a humiliation in refusing to perform the so-called minor operation.

Every surgeon recalls readily many occasions on which he has been called upon to arrest hemorrhage after an inexpert circumcision or tonsillectomy, or to treat the serious and often fatal infection which has followed the removal of a corn, or after a

uterine curettage, an attempt to remove an innocent-looking tumor, or cutting into an aneurysm thinking it to be an abscess, etc. We are all familiar with cases in which functional impairment or loss has followed an attempt to remove a needle or other small foreign body without the aid of a properly taken *x*-ray picture and without sufficient aseptic precautions. We all know the crippling results of transverse incisions of fingers or toes, by cutting tendons when abscesses are opened. We have seen too many cases of cellulitis following the removal of wens and of the dire results of electrolysis in skin cases.

The catastrophes which may follow very serious imperative operations are often unavoidable and excusable, but the economic loss in time as well as the too frequent loss of life as a result of improper or delayed treatment, or of the inexpert performance of these minor operations under an untrained anesthetist have been too long endured.

What has been said regarding the treatment of the slightly wounded may well apply to the average treatment of fractures. In spite of the large experience in the treatment of fractures which the four and a half years of war has given us, we still see institutions which care for accident cases poorly equipped with proper appliances. We still note the transportation of fractured femurs and fractured arms without the application of proper splints. After witnessing the ease of transportation in war casualties by the use of the Thomas splint, it would seem that every railroad and large industry, all ambulances and certainly all hospitals, should not only be plentifully supplied with this splint, but that all who are called upon to attend accident cases should be taught its proper application, at least as far as transportation is concerned.

With the recent vast experience in the treatment of the slightly wounded in war as well as of the seriously wounded, with the outstanding picture of the vital effect upon the firing line of inexpert or delayed attention to the slightly wounded, with our civilian experience of the baneful effect of the neglect of minor cases in civilian surgery, does it not become our duty to

call more emphatic attention to the need of proper organization in our civilian hospitals and in our smaller communities to assure better attention to the less as well as to the greater injuries, to the minor as well as to the major operation? Suffering and disability to the individual and economic loss to the community may thus be minimized.

WHAT WOULD BE THE BENEFIT TO THE CIVILIAN SURGEON IN THE EXPERIENCE GAINED BY OUR MILITARY SURGEONS IN THE RECENT WORLD WAR?

By EDGAR A. VANDER VEER, M.D.
ALBANY, N. Y.

The civilian surgeon who has not been able to take an active part in the late war, and who has had little experience with military surgery, with possibly the exception of dressing a few wounds in the Spanish-American War, must gain much additional knowledge from the splendid papers that are now being presented on this subject. He must make his final deductions from this analysis of war surgery, as it bears upon the treatment of severe railway and industrial wounds. This also applies to abdominal, thoracic and head injuries, as well as the treatment of fractures and hemorrhage.

To the surgeon of large civil and hospital practice the papers in our medical journals, for the first two years, would make it appear that the actual progress had been comparatively small. Our aseptic technic broke down early in the war, and, apparently, the surgeon was compelled to fall back on first principles and the antiseptic method. In his reading the civil surgeon had in mind the great number wounded by the fearful effect of high explosive shells, of air bombing, of long distance artillery, of machine guns, mines and shrapnel, the laying down of the barrage, and compared them to his own surgical practice. Then there are also the accidents occurring aboard steamers, from a diversity of causes, the crashing of falling buildings and fire walls, the explosion of powder magazines, likewise the more

fearful crushing wounds that come from the falling of heavy bodies, all these tending to produce great shock.

It is here that additional experience is sought in the method of procedure, particularly in railway surgery, industrial accidents and the immediate treatment of hemorrhage.

In the transportation of wounded we have an illustration that can well be followed out in the treatment of railway cases, in the principles embraced in our transcontinental hospital trains. The method of transporting wounded soldiers from the place of injury, and for long distances, by motor, water or railway train, presents a lesson that can be made applicable in civil practice. For some time the civil surgeon meeting with these conditions has recognized the serious additional depression of long transportation in this class of wounded, as well as cases of acute hemorrhage, and has said in his own mind and in discussion: "It is better that I hasten to the wounded man than that he be brought so far to me." This additional exaction upon the patient's failing strength may be the last factor that terminates his case fatally.

The treatment of hemorrhage is one in which laboratory work, as well as the experimental efforts of many of our ablest civil surgeons, has resulted in great advances, but in the main will their conclusions be confirmed?

Have the excellent laboratories they had at the front made much clearer the subject of transfusion, either by the normal saline solution, and its modifications and the various preparations of blood, or the more direct, effectual and perfect method of blood infusion?

In the first and second years of the war the treatment of wounds, on the basis of the employment of sterile dressings, the sterilization of surgeon, patient, instruments, etc., left rather a cloudy, doubtful state of mind in the mind of the civil surgeon as to whether war surgery was accomplishing all that might be said of it, and in connection with our past knowledge of civil surgery. The loss of life from rapid infection following closed wounds, which became so serious, the loss of patients from

tetanus—a condition that, in civil life, we felt was pretty well under control—the new kinds of wounds, from swift-moving heavy missiles, at the same time shell wounds containing poisonous gases, and trench fighting, which developed ground infection, all brought a shock to many an active civil surgeon, who had quite comforted himself with much better results than were early published regarding the treatment of wounds among the allied armies.

As a matter of fact, in free suppuration and acute abscesses, war surgery has not progressed much in advance of our other modern wars. We now know the cause of infection, but the treatment then was much the same as now.

Wounded are transported much more quickly than formerly, and are operated upon much more expeditiously, so that the risk of infection is less, but otherwise the treatment is much the same.

In the first years of the war it began to appear that the lower mortality rate was apparently due more to the treatment of diseased conditions of the men than to their surgical treatment.

Later, the prophylactic treatment of tetanus, the open treatment of serious wounds, the removal of tissue that would inevitably slough and cause infection, confirmed our experience in civil life. Here we felt that civil surgery was being paralleled, however, with this distinction, that war wounds, the serious nature of which I have referred to, bring a more distinct line of injury to muscle, bone, nerve and circulatory system than the slow, crushing wounds of railway accidents or the falling of heavy weights upon a limb in industrial injuries. In these cases many a civil surgeon was distressed to note the amount of serious infection and loss of life resulting in war surgery. We were not surprised to see a return to antiseptic surgery, the use of supposed germicides, and to note that the observing army surgeon, as reported from the active military hospitals in France, Belgium, and, to some degree, in England, were also experimenting in simply cleansing the wound, this line of aseptic treatment bringing better, and even excellent, results.

Different methods bearing the name of eminent research workers, and laboratory surgeons, who have been able to carry their experiments into actual practice, are not yet so firmly grounded, nor do they present such uniform results as to convince the civil surgeon that there is but one line of procedure, but one course to pursue in these cases.

Apparently the Carrel-Dakin method is of considerable benefit in the treatment of wounds of bones and joints, but it is very painful and the patients require large doses of morphine to make them comfortable. This and kindred methods are all good in their way, but much too complicated and costly to be used in ordinary civil hospital practice. Undoubtedly the Carrel-Dakin method is of much benefit when it can be carried out as planned by its author, but only a few civilian hospitals can furnish the nurses and attendants to do it properly.

Therefore, it seems to me the civilian surgeon may well continue the methods he has been accustomed to employ, and which have given him good results.

Reports from the large hospitals show that the wounded are still suffering from general sepsis a long time after the beginning of treatment, in spite of any of the methods employed.

The tests made, and the belief established that there must be a total absence of all pathogenic microörganisms from our field of operation when completed, and the wound ready for closure, have been given a severe trial.

It is possible, we must admit, that Nature is capable of doing a great deal in assisting the surgeon at this point, if she receives proper protection and encouragement by a not too severe antiseptic method.

Whatever we do we should constantly keep in mind our endeavor to obtain perfect wound healing, and surely this war has taught us that the pus-producing powers are always alert and ready to perform their unhappy intrusion by causing infection.

Any civil surgeon who has had an extensive practice and is accustomed to being called to distant places in the country,

has been surprised to note the serious condition of the patient who had been injured less than twenty-four hours previously. Possibly the foot, leg or arm of the patient became entangled in the cutting bar of the mowing machine, or in some way in the reaper, or an open wound has been dragged over surface ground by some farm machine. In the former class of wounds, in going over the meadow, the surgeon was surprised to note how clean the grass or grain stubble appeared, or in the latter case the plowed ground would attract his attention regarding the possibility of infection from barnyard manure. In these cases he has also been surprised to observe how rapidly infection has taken place, and to find that already the lacerated wound of the arm, ankle or leg, with or without a fractured bone, had produced a swelling hardly to be realized in size; that when handling the parts there was to be noted a marked condition like that of emphysema of the chest, in a punctured wound of the lung. Recent work in the laboratory has told him that this is an infection caused by the Bacillus aërogenes capsulatum, gas infection. If yet within the treatment of surgery it would perhaps mean the loss of the limb or immense sloughing or, at least, require free incision and drainage, while the serum treatment has seemed to do some good.

In the treatment of gas gangrene, it is hoped such a thorough trial will be made of Doctor Flexner's antitoxin as to bring us further and reliable data.

We were not surprised to hear of these war cases, and the term hospital gangrene had only a meaning of location. We have watched treatment with keen interest, and believe much credit is due some of our army surgeons for their exceedingly forceful, brave operative intervention.

I am sure I echo the opinion of many civil surgeons by emphasizing the belief that in the treatment of these cases something has been gained from the reports we have received to date through our medical journals, especially regarding the manner of doing the required amputations.

Then the civil surgeon reviews in his mind the final analysis

in the use of anesthetics; what additional knowledge will we acquire from the experience of our able war surgeons on this subject? We fancy, if we refer to the statistics of today, we are somewhat inclined to the belief that ether and chloroform have sustained their past reputation as anesthetics, but, on the other hand, that the employment of nitrous oxide, together with oxygen, has found a substantial lodgment, and is to be respected in the treatment of shock cases, here bringing better results than have heretofore been deemed possible; that local anesthesia has not advanced greatly in its application to military wounds is not disappointing. (Undoubtedly much good is to follow the careful study and presentation of papers by our returning surgeons, as well as the discussions that must inevitably result in such meetings as we are now holding in Atlantic City.)

Undoubtedly in the treatment of fractures important advances have been made. The use of the Thomas splint and methods employed by Doctor Blake and other surgeons have been of great benefit and have marked quite an advance in that direction. Also we have grown away from bone-plating and the use of artificial methods to encourage the healing of fractures.

The standardization of splints is likely to make a favorable impression, and be of great value. This is also applicable to the dressings accompanying the employment of the simplified and most practical splint, doing away with the frequent examination of wound dressings, and making transportation much more comfortable for the patient; however, in the actual use great care must be exercised, and joints watched, especially knee- and hip-joints, regarding any malposition that may be produced.

Possibly, in connection with this work, we are to have more complete and exact results from *x*-ray investigation. More exact experts undoubtedly will develop radiographs that can be interpreted so clearly and convincingly to the civilian surgeon as to be of great help to the latter.

The report on the work of the *x*-ray laboratory at the front is likely to present an amount of information that will be of great value to the surgeon in civil life.

In wounds of the abdomen, regarding the first suggestion of not operating until reaction had taken place, our surgeons have gone back to the original technic of operating as soon as possible after the receipt of the wound and with as little transportation of the patient as necessary. In this method of operating serious hemorrhage is controlled and the closing of the opening in the intestinal tract lessens traumatic peritonitis.

In the treatment of wounds of the chest we have learned much, and in my opinion that is the greatest advance which surgery has made in this war. Apparently it has been demonstrated that the thoracic cavity can easily be opened with almost as much impunity as that of the abdomen, joints or the brain. And it is along the line of thoracic surgery that our next great surgical advance has already been or will be made.

Of the major operations that have been performed in this war, it is believed there will be shown a much less percentage of amputations and that the recoveries in operations done within the abdomen will be greater than in any previous war. This will also embrace operations within the thorax.

In the operations about the head statistics thus far accumulated develop the fact that the steel helmet has certainly been a source of great protection, there being fewer scalp wounds and evidence of injury to the skull. Can we gain anything from this in protecting our industrial workers?

A factor of great importance presents in the reconstructive work that is being executed so thoroughly by and under the direction of the Surgeon-General. The liberal appropriations made by the government enable the fitting out of assigned hospitals for doing this work on a more extensive scale than has yet been established by the generosity of private individuals or public hospitals.

The wounded soldier, as well as those yet suffering from the

effects of army exposure and disease, is not permitted to return to his home until everything possible has been done for him.

It must be recognized that the United States Government has given to the Surgeon-General's Office a very generous amount of funds so that everything pertaining to up-to-date surgery and hygienic apparatus has been furnished.

The profession and public at large are hoping for great benefits to accrue to these wounded patriots, and in the final analysis the civilian surgeon must gather a vast amount of practical and valuable information.

Above all would the civil surgeon recognize the immense advance that has been made in the system of nursing, in the preparation of dressings, and through the Red Cross work by the women of America, who have worked so faithfully, so intelligently, so persistently in their efforts to help the American soldier.

THE NO-FLAP OR GUILLOTINE AMPUTATION: AN UNFORTUNATE RESURRECTION

By JOHN H. GIBBON, M.D.
PHILADELPHIA

What I have to say in this brief communication is well epitomized in the title. The method of simply making a circular amputation of an extremity, dividing all the structures, skin, muscle and bone, at the same level, is a resurrection, and what I have seen after these amputations, the frequent secondary hemorrhages, the slow healing extending over months, the painful dressings and the secondary operations, which are necessary in nearly all of them, cause me to designate the resurrection as unfortunate.

My first sight of these stumps was at a British Base Hospital, where we had them in great numbers, and where we were obliged to operate often for secondary hemorrhage, usually from the femoral artery. Repeated hemorrhages occurred in a number of thigh amputations necessitating ligation of the common femoral in many instances.

In spite of the constant irrigation of the wound with solutions, the adherence of the gauze to the raw surfaces, and especially to the exposed nerves, made the dressing for a number of weeks an extremely painful procedure, notwithstanding the fortitude of the British Tommy. All kinds of devices were used to prevent this sticking of the dressings and thus lessen the pain, but none was very successful until the surface had become well covered with granulation tissue.

The application of appliances to draw down the skin, which

had already in most instances become fixed at the edges, was itself a painful and troublesome procedure, and too often did not succeed sufficiently to obviate the performance of a secondary amputation or a plastic operation.

Because of these dangers and difficulties it would seem that there must have been some very strong reasons to justify this type of amputation. The justification seemed to rest on these two reasons: that it was life-saving, because it was quickly done, especially in the cases of gas gangrene, which was the common cause of amputation in this war, and that it gave a good stump for an artificial limb. For these reasons this method of amputation became generally universal in France, and yet I do not think either or both justified the practice because of the complications already enumerated, and I believe I did and saw enouhg amputations later, when a skin flap was made and reflected to an extent that fully exposed the divided muscles, and when healing was fairly prompt and a good conical stump found, to prove that the guillotine amputation had no place, or a very limited place, in war surgery. It may be said that the reflected flap method does not obviate the painful dressings and the secondary hemorrhages; but this is not true, for in every instance in which prompt evacuation or death did not occur tho wound had become sufficiently clean in from four to ten days to permit the bringing down of the flaps, and I can recall no case of secondary hemorrhage after the sterilization of the stump and the approximation of the flaps. The hemorrhages which I saw in the cases of guillotine amputation occurred after the tenth day. The making and the reflection of the flaps occupies but a few minutes and cannot greatly increase the shock. A circular suture passed around the ligated stump of the vessels buries sufficiently to ensure against early hemorrhage. If the flaps are properly reflected the wound is as wide open as the guillotine amputation. I employed these reflected flaps in a number of thigh amputations for gas gangrene, first at a British Base and later at a Casualty Clearing Station, and in a large part of the American Sector still later this method became the rule. My opinion then is not based on theory but on

experience with both types of operation, and it is very fixed that the no-flap amputation is an unfortunate resurrection.

But I have said nothing of the second reason for doing the no-flap operation—namely, that it gives a better stump for the wearing of an artificial leg. All I have to say is that the reflected skin flap amputation gives exactly the same type of stump, but gives it earlier, with less suffering and less danger, and, that if it does not, then we must employ the guillotine method in civil practice.

Are we prepared to do it?

DISCUSSION ON THE PAPERS OF DRS. DEPAGE, CRILE, LOWER, VANDER VEER AND GIBBON

Dr. John H. Gibbon, Philadelphia:

I should have been glad to yield the time for the reading of my paper, but since some questioning reference has been made to the title I do not wish to put myself in the position of exhibiting a target and then withdrawing it before one could take shot at it. In the first place I want to take this occasion to pay my respects and express the obligation which I think every surgeon working in France owes to Dr. Depage. A paper which Dr. Depage read at Paris in February, 1918, was used as the "articles of faith" by the men working in our first evacuation hospitals. Dr. Depage said at that time nothing about the no-flap amputation, and in this respect we did not follow Depage, but we owe to him more than to any other man what we were able to accomplish in the treatment of the wounded in France.

In reference to Dr. Crile's paper, I, like you all, always enjoy what he has to say. Dr. Crile is an optimist, and I am, too, but the society of optimists is a limited order; and I am inclined to believe that nitrous oxide, fresh air, and a cheerful spirit will not take the place of the Carrel-Dakin treatment in the sterilization of wounds, neither can I say that I have seen satisfactory results from blood transfusion in acute infection. I may be wrong about it, but I am speaking particularly of the work in the advanced hospitals where I have seen transfusion done a number of times in the men badly shocked and in those who developed a serious infection. What was the experience in the base hospitals I do not know. In the advanced hospitals, however, I have seen nothing but temporary benefit. The men would be braced up for three or four hours and would then die.

Another point upon which we optimists disagree is that the patient himself has very much to do in the matter of reaction to infection. I saw a great many wounded in Belgium in the worst conditions of winter. I saw a great many wounded in a much pleasanter part of the world in the spring and summer and fall of the next year, and I cannot say that I observed any particular difference in the reaction of the individual patients to infection. There is one other thing I find, too, with which I am not in accord: Dr. Crile emphasized the fact that antisepsis played no part in the permanent closure of wounds of joints. We are all agreed that the most important element in the treatment of wounds is the first operation, that it should be thorough and complete. No one, however, can say that the use of antiseptics can be eliminated in the sterilization of infected wounds.

In every other respect I agree heartily with what my fellow optimist has to say.

Dr. Vander Veer spoke of the use of morphin for pain in the Carrel-Dakin treatment. I have never seen morphin used in the carrying out of the Carrel-Dakin treatment, and if the pain is so great as to require morphin, I would say that the Carrel-Dakin treatment is not being properly applied. Moreover, Dr. Vander Veer has said, if I understood him correctly, that in civil practice we will continue our old methods. If we do it is a sad commentary on our intelligence.

Dr. Thomas W. Huntington, San Francisco:

Leaving the main subject which has been brought before us, I wish to refer to one point very clearly set forth by Dr. Crile. Attention should be directed especially to the female trained nurse in war surgery and the part which she has played in recent years.

In England and France female nurses were welcomed. In Italy, however, there was a general impression on the part of surgeons that female nurses could not be made available for use in Italian hospitals. From various sources I received the assurance from Italian surgeons that as Italians are an impressionable race and very susceptible, it would not be safe to place female nurses in charge of their wards and operating rooms. For this reason the first year of Italian experience in recent war-nursing was mainly in the hands of orderlies and enlisted men. An entirely different view of this question, however, was presented by Sir Alexander Ogsten, who very early established a British Red Cross Hospital near Udine. Sir Alexander has had experience in eight different notable military campaigns. When I propounded this question to him he replied instantly: "Italian soldiers are just as amenable and appreciative of the influence of the female nurse in wards and operating rooms as is any other race of people," and he closed this comment by the following statement: "Without the trained nurse I feel that I should be helpless. Rather than deprive myself of this essential in hospital equipment I should feel that the English Red Cross Hospital in Italy had better close its doors and abandon its effort to relieve the sufferings of those who have enjoyed its privilege."

A splendid tribute to the efficiency and self-sacrifice of the military female nurse should be indelibly written into the history of the past four years.

Dr. Alexis V. Moschcowitz, New York:

Just a year ago I related to you the story of my experience with the Carrel-Dakin treatment; it is one which bears repetition. When

the first publications regarding the subject appeared the method appealed to me so strongly that I introduced it in my hospital. My results with the method were a complete failure, and after giving it, as I thought, a faithful trial of three months I not only cast it overboard, but even publicly spoke against its use. When the War Demonstration Hospital of the Rockefeller Institute opened up I availed myself of the cordial invitation of Dr. Carrel to visit it, and I did so for several weeks. I soon learned the causes of my failure, the most important of which was that I thought I used the Carrel-Dakin treatment, but in reality did not. Since that time I have reintroduced it both in my civil and military practice, and my results are simply ideal.

I am thoroughly convinced of the efficiency of the Carrel-Dakin treatment in dealing with infections "if properly used." The question is not between surgery and the Carrel-Dakin treatment—the latter will not take the place of good surgery; it is, however, a wonderful adjuvant in the treatment of infected wounds. I propose to continue and extend its use in my service.

Dr. Henry H. M. Lyle, New York:

The speaker feels he cannot agree entirely with Dr. Crile's statement that two of the most successful features of the war surgery in the A. E. F. were the use of nitrous-oxide-oxygen anesthesia and the primary suture of wounds.

Gas and oxygen given under ideal conditions and by one specially trained in it is undoubtedly a splendid thing. In order to make a just estimate we must ask ourselves how often were these conditions fulfilled during active warfare. In the First Army, and that was the only army that fought, a few of the evacuation and mobile hospitals had gas-oxygen equipment. There were seven of these in actual use. Contrast this with over 100,000 wounded evacuated by the first army and you will see what a small part gas-oxygen played.

Even if we disregard the transportation difficulties attendant on gas-oxygen supplies, we must remember that it is a very dangerous anesthetic in the hands of the inexperienced. It will always be impossible to provide enough skilled gas-oxygen anesthetists to go around. Of necessity most of this work will have to be done by the corps men.

Whatever may have been our preconceived ideas about anesthesia, the First Army's experience has forced us to conclude that ether is the safest, best and the most widely applicable anesthetic for the surgery of the advanced zones. In selected cases and for base hospital work gas-oxygen has its place.

Regarding the primary suture of wounds, we must differ from Dr. Crile. Given ideal conditions primary suture is the ideal surgery, but 75 per cent. of war surgery consists of overcoming adverse conditions. The speaker saw many surgical disasters following this method during the battle of the Somme in 1916, and his experience with the first army has taught him that primary suture should never be employed except in joint and chest cases. A wide, thorough débridement, adequate splinting, coupled with warmth and nourishment, are the cardinal necessities in the surgery of the advance. To obtain these requisites under adverse conditions medical officers with common-sense and the will to see it through are absolute essentials. As ambulance director and consulting surgeon to the First Army, the speaker had an ample opportunity to note the practical results following the change in the surgical handling of the wounded. During the first phase of the Meuse-Argonne offensive, 10,117 unoperated wounded were sent out of the army zone; during the second phase only 295 were evacuated. These figures speak for themselves.

Dr. George E. Brewer, New York City:

I will speak for a moment on one aspect of Dr. Crile's paper, that of the treatment of shock. One of the most important things which occurred during the war in this connection was the organization of shock teams. I do not know whether you know about it or not, but after the British offensive in 1917 it was suggested to our chief surgeon that in our future work we should treat shock by definitely trained shock teams. The cause of that was the fact with which we were all familiar, that in the British offensive, often the least experienced men in the advanced hospitals were assigned to the shock wards. We saw that the treatment of shock consisted largely in the giving of intravenous injections, a good deal of saline by the rectum and a large amount of morphin. The advanced hospitals organized for the American troops had the first shock teams, so far as I know, ever introduced into any army. With each shock team were two men expert in the treatment of shock and from two to four nurses and orderlies. These were supplied with appliances for blood transfusion, for the use of the gum acacia solution, and in fact with every means of stimulation. This work was largely organized before our offensive took place. As a matter of fact, a shock team was first employed—in the Advanced U. S. A. Hospital of Bussey Château, with the 42d Division, then with the 4th French Army—during the last great German offensive, July 15, 1918. And our shocked cases received such splendid treatment, that from that time there was a shock team introduced into every front area hospital so far as I know until the

end of the war. In addition we had shock teams at our ambulance dressing-stations. It is a point upon which I think we were all agreed that the presence of these trained men with all the necessary apparatus was of immense value in the treatment of shock and that we could not commend the carrying on of this work too highly.

Dr. Howard Lilienthal, New York City:

One word about transfusion, because there has been given to us two opinions: one by Dr. Crile and one by Dr. Gibbon. It is necessary to remember that Dr. Gibbon, speaking entirely of front-area surgery, refers to transfusion in septic cases whether or not there is a history of bleeding. I have worked in front-area surgery also, and my experience leads me to an entirely different opinion from that of Dr. Gibbon. When a patient comes in, if he has lost blood, it does not matter whether he is septic or not. The most powerful influence for his good is the replacement of that blood—it is a matter of mere addition. As to the sepsis, you do not know when you get a septic man at the front how much blood may have been lost before he reached your hospital. I am convinced there is nothing quite so good in the cases of profound acute anemia with or without sepsis as blood transfusion.

Dr. Astley P. C. Ashhurst, Philadelphia:

I suspect that I am one of those to whom Dr. Gibbon refers as pessimists. I approve of the guillotine amputation and always employed it where indicated. If one looks through the *Bulletins* of the Surgical Society of Paris, which after all give the best general view of modern war surgery that can be obtained, because everything (whether sensible or foolish) is discussed at length, one finds that the guillotine method, first used in the war by Pauchet, of Amiens, was originally condemned by everyone else in the Society except by Quénu. Now Quénu, it seems, had an open mind, and acknowledged there might be occasions when the guillotine method was advisable; and he even acknowledged that he had occasionally adopted it in civil practice. Gradually, during the course of the war, this opposition was overcome and the method became well established with the French.

It is applicable in active warfare, not in stationary warfare, where you can operate as in civil life, keeping the patient and caring for him until he is well. In active warfare you operate at high speed, averaging three patients an hour, if possible, and all amputation cases except patients with gas gangrene must be sent right off to the rear. If amputation is by the guillotine method, not only is the least possible

area of tissue exposed to possible infection, and the least area left for granulation, but there is preserved the greatest possible length of stump for use with an artificial limb. When the patients get back to the rear the soft parts can be pulled down to a considerable extent by adhesive plaster traction. If this traction is applied within a week or ten days of the operation about 30 per cent. of these guillotine stumps will close without secondary operation. I may add, moreover, having seen hundreds and hundreds — perhaps I could say thousands—of stumps in France and this country, over a period of many months, that there remains no question in my own mind, nor I believe in the minds of those surgeons who were called upon to do the reamputations, that the guillotine amputations were much more easily sterilized and closed, and gave eventually more useful stumps than those where skin-flaps had been employed.

The fact that Dr. Gibbon saw with the British service many bad results from the guillotine amputation suggests that these stumps had not been treated properly soon after the operation, that they were left lying in the ward without traction and without antiseptic treatment. That, however, is not to be held against the guillotine method of performing the humane operation.

As to the question of transfusion, no one has mentioned what is I think a most important observation of Dr. Depage regarding the indication for transfusion in acute hemorrhage. He pointed out in 1915 that if in the first six hours the red blood count fell below 4,000,000, practically all the patients died unless transfusion was done.

As I said in the beginning, I am a pessimist. I believe that as truly as we cannot have day unless we have night, so we cannot have peace unless we have war; also, that we are going to have more wars in our own lifetime, and that this is not the time to forget about war surgery, but to learn the whole truth about it.

TREATMENT OF RECENT WOUNDS OF THE KNEE-JOINT

By EUGENE HILLHOUSE POOL, A.B., M.D.
NEW YORK
AND
JOHN H. JOPSON, M.D.
PHILADELPHIA

We will confine our remarks to the immediate treatment of wounds of the knee-joint by projectiles, that is, bullets, fragments of shells, etc. The observations upon which the paper is based are mainly 34 cases operated upon by the writers at Evacuation Hospital No. 1, A. E. F.

One of the most important lessons which war surgery has taught is the amenability to surgical treatment of wounds of the large joints. The pessimistic views which were formerly held in regard to these lesions were due to an undervaluation of the resistance to contamination and infection which the synovial membrane of a joint offers; and a failure to comprehend the proper operative procedures. But during the last two years of the war it became evident that the features which are of importance in the treatment of battle casualties of other types, particularly early operation and complete excision of traumatized and contaminated tissue with removal of foreign bodies, are likewise indicated in the treatment of wounds of the large joints. But, whereas in other types of wounds it was often found advisable to leave the wound unsutured and to supplement the operative treatment by chemical sterilization before proceeding to a final closure, in the case of a joint primary closure of the synovial membrane is essential to success, and an unsutured joint with or without postoperative chemical steriliza-

tion has not in general proved satisfactory. Therefore, since the surgeon must rely upon the primary operation for the prevention of intra-articular infection, the principles of débridement as applied to wounds of the soft parts, bones and cartilage must be understood and practiced.

Indications for Operative Treatment of Recent Wounds of Joints. All wounds of joints by projectiles, except certain perforating (through and through) wounds by bullets, should be operated upon.

Perforating bullet wounds are not operated upon by most surgeons if the wounds of entrance and exit are punctate and there is no evidence of displacement of fragments or hemorrhage. Punctate wounds are made by a bullet of high velocity with no explosive effect and no deflection during its course through the limb. In such cases the bullet cuts through clothing and tissues carrying few organisms into the wound and producing little destruction of soft tissues or comminution of bone. Experience has demonstrated that under these conditions infection usually does not occur even when a fracture is present. Therefore these cases do not demand immediate operation. They should, however, be carefully watched and distention of the joint should be treated in the manner described in the after-care of operated cases.

A careful preliminary examination of the patient and his lesions is essential. The extent of involvement of the bone and the presence and position of retained foreign bodies should be established by the *x*-ray. Moreover, the time elapsed since the wound was received, the location of the wound, the extent of injury to the soft parts, complicating lesions of the main bloodvessels and large nerves, and the general condition of the patient are, as in other battle casualties, factors which must be weighed before a plan of action can be decided upon.

After careful consideration of the conditions enumerated the surgeon should proceed as far as possible in accordance with a definite plan. The choice between amputation and conservation of the limb usually should be made before the operation is

begun; the choice between resection and joint preservation is made as the operation proceeds.

We will not dwell upon the indications for amputation as it is with the technic of conservative treatment that we are mainly concerned. We believe that the results of conservative treatment are sufficiently good to weigh in its favor in cases of doubt, and that more mistakes will be made by a persistently radical than by a persistently conservative policy. While the degree of mutilation of the soft parts and the extent of comminution of bone are of great importance in deciding for or against amputation, it is in cases complicated by wounds of the main vessels that the decision is most difficult and most urgent. In the cases which we observed where an open knee-joint was associated with a wound of the popliteal or femoral artery, amputation ultimately became necessary except in one instance. This exception was an open knee-joint without bone involvement complicated by a wound of the popliteal artery. Arthrotomy and ligation of the popliteal artery were followed by a good functional result.

Technic. The principles of conservative treatment may be summarized as follows: Complete débridement of the tract of the projectile through the joint; absolute closure of the joint by suture; primary or delayed closure of the superficial parts according to the rules laid down for primary suture of the soft parts alone; finally, early active motion.

The incision or incisions must be placed so as to permit not only thorough débridement of the soft parts, but also free access to the foreign body and involved bone. Though no rule can be formulated, longitudinal incisions, especially lateral incisions, are to be preferred when practicable. However, the position of the wound or wounds is in general the determining factor. Occasionally the incision may be curved or even transverse, but division of the patellar tendon should rarely be made. The primary incision includes the wound of entrance and is often supplemented by a second incision. In a perforating wound the second incision includes the wound of exit; in a penetrating

wound it is placed in such position as to expose a retained foreign body which otherwise would be inaccessible.

It is sometimes necessary to supplement a longitudinal incision of the superficial tissues and capsule by a limited transverse incision of the capsule.

Through these incisions débridement of the soft parts proceeds as in operations elsewhere. The technic is practically the same as for wounds of the soft parts alone. The niceties of technic in respect to asepsis and adequate exposure must be fully observed, and traumatization of the synovial membrane should be reduced to a minimum.

We will consider first the simplest type of case: a type, however, which is relatively frequent, namely, small perforating and penetrating wounds with little or no bone involvement. In these the bullet or fragment of shell has either perforated the limb, traversing the joint in its course; or has penetrated the joint and lodged in it or in adjacent tissues. In some of these it is difficult to determine whether the joint has been penetrated. But, after the capsule has been exposed, the orifice into the joint must be demonstrated before the joint is opened. Great care should be exercised to avoid opening a joint that is uninvolved, and, similarly, not to neglect proper operative measures in a joint that is involved. The capsule and synovial membrane should be opened by a liberal incision with thorough elliptical débridement, conserving, however, all tissues that can be left safely. Foreign bodies must be removed, also loose fragments of bone. A wound of the bone or articular cartilage should be treated as outlined later. The joint is thoroughly irrigated with salt solution and then distended several times with ether. The synovial membrane and capsule are closed with fine catgut. When feasible these two layers should be sutured independently. *Complete closure of the joint without drainage is the invariable rule.* The soft parts overlying the capsule may be closed or left open for subsequent suture according to the same rules as are followed in wounds of the soft parts alone. In wounds of limited extent operated upon early

and retained for observation a primary closure may be practised. Otherwise the soft parts should be left open. Delayed primary suture may then be made in many cases within a week. Primary suture increases the danger of joint infection by inward extension of a superficial infection. On the other hand, leaving the soft parts unsutured may delay the institution of early movements.

When, as is often the case, the tract involves an articular surface with destruction of bone and cartilage, the tract must be followed and cleansed as thoroughly as possible. That is, it is treated on the principle of removal of contaminated tissue. This should be done with gouge, chisel, curette or elevator, but with the sacrifice of as little bone as possible. The curette is less satisfactory but is often necessary. Obviously the débridement cannot be and should not be as thorough as that of the soft parts.

In some of our cases the injury to the articular surface has consisted in a limited and incomplete separation of a layer of cartilage with a thin layer of underlying bone. In such cases it is advisable to remove the partly separated and poorly nourished layer of cartilage and to cleanse with chisel, gouge or curette the surface from which it has been detached.

Where a considerable area of condyle or articulating surface with a preponderance of bone is partially detached but retains good contact with the overlying soft parts, the fragment is left after the tract has been followed and the fractured surfaces have been cleansed as thoroughly as possible. If an attached fragment is to be removed this should be done if possible by the subperiosteal method of Leriche using his modification of the sharp Ollier elevator. By this method a reformation of the bone is more probable. Compound fractures of the *patella* should be treated by removal of completely separated fragments and preservation of large attached fragments which should be approximated if possible by suture. Complete removal of the patella should be avoided, since the functional result is poor.

In extensive involvement of the articular surfaces, an effort

should be made to save the joint, provided the conservable articular surfaces and soft parts are sufficient to warrant a reasonable hope of securing a useful joint. In this connection it must be borne in mind that stability is essential in the knee.

When there is such loss of the articular surfaces as to preclude obtaining a useful joint, resection should be elected. As Lemaitre emphasizes, primary resection is to be preferred to a poor functional result with deformity. For instance, complete removal of a condyle will result in so much lateral mobility as to necessitate subsequent resection. When the bone lesion is so extensive as to necessitate resection through the narrow shaft above the condyles, amputation is in general preferable.

When there is such destruction of the soft parts that the edges of the capsule cannot be approximated, if an attempt is to be made to save the joint, the defect in the capsule should be completely closed with muscle or fascia. In cases where this was impossible, we have seen a partial closure made and the wound treated by the Carrel method, the aim being to close the joint subsequently by a plastic operation. However, we have not seen this method successfully carried out without infection. Much difficulty may be experienced when excision of a portion of the head of the tibia has been necessary. The defect is difficult to close. When the loss of articular surface is slight we found it possible to supplement the deficiency in the capsule by turning in a flap of fascia from an adjoining part and suturing it in place so as to complete the closure. If the loss of articular surface is considerable resection is usually necessary.

In all cases before the joint is closed complete hemostasis should be obtained. The joint is then thoroughly washed with salt solution to remove blood, bone fragments and débris. This is followed by lavage with ether under sufficient pressure to distend the joint. Although this use of ether is empirical it appears to exert a beneficial influence. Closure of the joint is obligatory.

In compound fractures associated with a wound above or

below the knee in which the joint is not directly involved, but with one or more lines of fracture extending into the joint, infection frequently develops. If hemarthrosis is marked we believe that arthrotomy, irrigation and closure is in general indicated in addition to the operative treatment of the wound.

Postoperative Care. It must be emphasized that the ultimate outcome of the case, namely the early reëstablishment of the function of the part, must be aimed at from the first. *Early active mobilization is the rule.* The patient should be encouraged and directed to move the joint as soon as the operator feels that this can be done without exciting hemorrhage or interfering with tissue repair. For instance, following a transverse wound with removal or suture of the patella, or after summary suture of an extensive wound involving the muscles of the thigh, a period of immobilization must be enforced. On the other hand, in the type of wound with little involvement of bone and soft parts a splint need not be applied; the patient should flex and extend the knee as soon as possible and he may be allowed to walk by the tenth day or sooner. Early use of the joint is essential for early restoration of function. *In the treatment of wounds associated with fracture*, mobilization of the joint is not indicated if it is likely to interfere with alignment or union or promote excessive callus formation.

Though we approve of the doctrine of Willems, we practised early mobility rather than immediate mobility in the postoperative treatment of our clean closed joints.

Superficial infection may only require the removal of a few stitches; more extensive infection of the superficial tissues requires reopening of the entire wound to the capsule. The wound should be Carrelled and may be suturable subsequently.

If the joint becomes distended, and infection is suspected, it should be aspirated immediately and a culture made. We have seen turbid fluid containing diplococci aspirated from a distended joint on the third day after operation and uneventful recovery follow; we have also seen much turbid fluid evacuated from between the sutures in the capsule on the second and again on

the fourth day by pressure on the subcrural bursa. In this case the joint was markedly distended until the fourth day. Possibly as a result of that distention, there was no limitation of motion by the soft parts at any time. This patient quickly regained complete function and was back at the front in six weeks.

If the patient's condition, the local examination, the character or culture of the aspirated fluid indicate pyogenic infection, lateral incisions should be made at once, or if the original incision is so placed as to allow satisfactory drainage it should be reopened and the treatment for suppurative arthritis begun.

Suppurative Arthritis of the Knee-joint. Willems's method is here recommended. The important feature is to drain early. Lateral incisions well back are the best; occasionally an incision elsewhere may be employed. No drains should be used. Splints are dispensed with or arranged for support without joint fixation. Free mobility every two hours should be enforced by *active* movements so as to evacuate the joint. Early non-virulent infections with little or no bone involvement usually do well. In severe or long-standing infections, especially with bone involvement, the treatment has not proved as satisfactory.

We have not included in this paper any reports or discussion of those long-standing and destructive infections of the knee-joint which demand resection or amputation. Our observation of wounds of the knee-joint has been to a large extent in an evacuation hospital under conditions favorable for long observation, and for estimation of the probable end-results. Although serious complications may have developed in some of the cases included in our series after they passed from our care, we believe that by the methods of treatment which have been outlined serious complications can, as a rule, be avoided. For these methods we are indebted to the surgeons of Belgium and France.

Analysis of Cases. In tabulating our cases, we have analyzed the preoperative histories with reference to the time elapsing before operation, the type of missile, the nature of the wound, the presence or absence of fracture, and the preoperative complica-

cations. The large proportion of wounds due to high explosives, as contrasted with those resulting from small arms, and the great majority of those penetrating and associated with a retained foreign body, was a characteristic feature of the prevailing trench warfare. The pistol wounds were of the accidental type, and were for the most part associated with severe fractures.

Total number of wounds of the knee-joint operated upon		34
Average time elapsing before operation (excluding one case of three days' duration in a French soldier)		11 hours
Shortest interval		3½ "
Longest interval		26 "
Type of missile: High explosive		25
Type of missile: Pistol		5
Type of missile: Rifle or machine gun		4
Penetrating wounds		25
High explosive	23	
Pistol or rifle	2	
Perforating wounds		9
High explosive	2	
Pistol or rifle	7	
Wounds with bone involvement		28
Femur	12	
Femur and tibia	3	
Femur and patella	6	
Tibia	3	
Patella	4	
Wounds without bone involvement		6
Complications.—Multiple wounds		10
Wounds of main bloodvessels		3
Femoral artery		1
Popliteal artery		1
Popliteal artery and vein		1
Contusion of peroneal nerve		2
Shock or hemorrhage or both		4
Gas gangrene (pre-operative)		2

In all except 2 cases the joint was sutured primarily. In 1 case primary amputation was necessary and in another an attempt was made to save a badly shattered limb, in which the

wound of the knee-joint was of secondary importance. This case came to amputation, but not for joint infection.

Primary amputation	1
Primary suture of joint	32
Primary closure of superficial wound	21
Delayed primary closure of superficial wound	4
Secondary suture superficial wound	4
Evacuated before suture of superficial wound	2
Amputation for vascular gangrene before skin wound was sutured	1
Amputation for gangrene of foot in case in which joint and soft parts were not closed. Gangrene resulted from gaiter with traction for two days prior to admission in French soldier	1

Wound Healing. The preservation of life, limb and function are mainly dependent on the avoidance of wound infection, and in the treatment of infected wounds of the type under consideration the success of the operation may be judged in part by the percentage of cases in which the surgeon is able to avoid or control this factor. The results obtained in our series are as follows:

Total number of infections during stay in hospital	8
Infections: Of joint and soft parts after primary suture	3
Infection of soft parts alone, severe, requiring reopening, Carrel and secondary suture	1
Infection limited and superficial, requiring the removal of only one or two sutures, not interfering with primary wound healing	4
Evacuated within twenty-four hours (this case was amputated at the base, details are lacking)	1

While in 3 cases there occurred joint infection, in but 1 did this result in ankylosis. In the others the infection was controlled by prompt reopening and Carrel treatment for two days.

In both of these the joint was sutured successfully after sterilization.

Secondary Amputations. In 2 cases this was required before evacuation. In neither was it done for infection. In one it was

for gangrene following an associated wound of the popliteal artery and vein, and in the second for gangrene of the foot, the result of prolonged pressure by the anklet used in connection with the Thomas splint which had been in place for two days before admission. In another case evacuated twenty-four hours after operation the record shows the limb was amputated later at a Base.

End-results. The average length of stay in the hospital was twenty-six days. Four patients at the end of several months were reported to be under treatment for a partial fibrous ankylosis with fair function. In these cases further improvement may reasonably be expected.

Deaths: Total number	2
1. Multiple wounds, gas gangrene, retroperitoneal infection.	
2. Multiple wounds, shock, gas gangrene.	
Amputations, primary	1
Amputations, secondary	2
Good functional result apparently assured at time of evacuation or from subsequent information (little or no limitation of joint movement and a stable weight-bearing limb)	15
Fair result (partial limitation of motion after several months; good weight-bearing limb)	4
Poor result from standpoint of function (one complete ankylosis the result of infection; one secondary resection for weak joint	2
Result as to function undetermined	7
One case evacuated within twenty-four hours, amputation at base	1

A review of tbe above results has confirmed us in the opinion that a conservative policy in dealing with wounds of the knee-joint caused by projectiles is justifiable and strongly indicated, whether it be viewed from the standpoint of mortality, preservation of limb or maintenance of function. It has shown us that infection can be avoided in the great majority of cases; that even when intra-articular infection develops function can sometimes be preserved, or if lost that amputation is not inevitable. Finally, that early active motion of the joint offers the best chance for an early and complete restoration of function.

The following are reports of such cases as present features of special interest:

CASE I.—Captain X. Wounded at 5 A.M., March 11, 1918, by a shell which exploded in the trench. Admitted about 7 P.M.; operating room at once, fourteen hours after injury. 1. *Wound outer side of left knee* 3 inches above joint; moderate hemarthrosis. *X*-ray showed foreign body in external condyle.

Operation. Three-inch longitudinal incision with excision of trajet which passed along and opened joint for $1\frac{1}{4}$ inches. Edges of opened synovia excised. Trajet led into condyle. This traced inward led to firmly embedded éclat one inch deep in bone fracturing articular surface. Edges of orifice in bone removed with rongeur, tract thoroughly curetted after removing éclat 8 mm. in diameter. Joint irrigated with saline and then ether. Synovial membrane completely closed. Superficial tissues sutured. Skin closed without drainage.

Bacteriological Examination. Culture from joint fluid and of éclat both showed few Gram-positive B.

Arm. Two wounds middle of arm (1) posterior; (2) external. *X*-ray showed two éclats, inner aspect of humerus above fracture; markedly comminuted fracture middle $\frac{1}{3}$ humerus. Longitudinal incisions removing each wound; careful débridement including a number of small splinters scattered through the tissues. Musculo-spiral nerve dissected three inches showed no evidence of injury, though paralysis developed. Third longitudinal incision over foreign bodies. These reached through biceps and removed, and tracts excised to bone. Posterior wound presented lacerated, bloodless, gray muscle; this freely excised. Cultures and smears of arm wounds revealed few staphylococci.

Dressings. Arm, Thomas, elevated with weights. Leg, Cabot, elevated with weights.

March 13. Temperature, 99°; pulse, 80. Comfortable. Dressed forty-eight hours. Knee, no effusion, clean. Arm clean; culture negative. Smears, few cocci — 1 : 5 fields.

March 14. Seventy hours postoperative delayed primary suture of arm (three wounds).

March 15. Temperature, etc., normal. Comfortable.

March 17. Temperature, etc., normal. Wounds dressed, clean. Swelling and ecchymosis of arm, no tenderness.

March 18. Seventh day, began active motion knee 5 degrees.

March 23. Twelfth day, Cabot splint removed from knee permanently.

Late result: Knee full function; arm was subsequently operated upon for musculospiral paralysis. Seen in New York, June, 1919, function of musculospiral is returning; apparently will soon have perfect use of muscles supplied by it.

CASE II (March 12, 1918).—Wounded by shell fragment penetrating knee. Operation four and one-half hours later. Transverse incision with débridement. Patella was in small fragments. Internal condyle in small fragments. Foreign body in popliteal space. Fragments of patella and condyle removed; foreign body removed through popliteal incision which was left open. Synovial membrane closed as fully as possible; soft parts closed completely.

March 14. Dressed. Considerable bleeding has occurred from posterior wound. Wounds look clean.

March 20. Movement of knee begun.

March 21. Posterior wound (popliteal) sutured under anesthesia. Movements tested, little lateral mobility and free flexion.

March 23. Put up with balanced weights for support during active motion. Flexion 15°. Temperature runs to 100°.

March 28. Developed tonsillitis; temperature, 103°; continued for five days.

April 5. Out of bed. To bear weight on leg daily and active movements. Hematoma developed in popliteal space opened and ℥iij blood clot evacuated. On evacuation, May 9, wounds healed, can flex 10° without pain, some fluid in joint.

The consideration of procedure at time of operation was as follows: Resection would mean great shortening; also a weak union due to peg-like narrow end of femur; also same dangers from infection as accompany conservative procedure. Subperiosteal resection was not feasible on account of length of such

an operation and the marked comminution. Amputation seemed too radical primarily; better deferred until result observed. It is probable, however, that resection or amputation would have been best since the patient will probably have a flail-joint. (It has been ascertained that resection of the knee-joint was performed August 21, 1918.)

Case III (March 26, 1918).—Wounded by shell fragment striking right knee. Walked two kilos. Operation three and one-half hours after injury. Much effusion. Small wound over patella. Éclat 5 inches higher in muscles of thigh. Patella fractured at upper part. Evidently struck on upper end of patella while knee was flexed. Six-inch long incision with débridement. Joint irrigated with saline and ether and closed. Tract through muscles could not be followed, therefore blindly excised and foreign body removed. Feared to close on account of possibility of anaërobes in muscles of thigh with questionable débridement. (Organisms, – 1 : 5 fields; anaërobes and diplococci in tissue removed with éclat.)

March 27 (eighteen hours dressed). Two organisms to field; culture, no growth.

March 28, 9.30 A.M. (forty hours postoperative). Delayed primary suture. Fourth day considerable bleeding. Hematoma in soft parts and swelling of knee.

April 9. Hematoma evacuated, wound sutured with rubber tissue drain.

April 17. Primary union, active motion.

Evacuated May 9. Went back to his organization about May 15 and was on duty during the fight near Soissons, taking long marches, etc., with no trouble or discomfort.

August 2; examined, no limp, flexion to right angle. Scar soft, movable, and no apparent adhesions.

April 2, 1919. Seen in New York, no discomfort, full use; 135° flexion.

Case IV.—Shell wound penetrating right knee, sustained April 9, 1918. Operation twenty-six hours later. Marked effusion, tenderness and pain. *X*-ray showed foreign body 1 cm.

outer side middle of outer condyle 1 cm. above articular margin. Excision wound of entrance and tract by longitudinal incision 3 inches long inner side of knee-joint. Joint distended with rather thick blood containing fat droplets. Smears showed one coccus to 5 fields. Toward end of evacuation of blood, pus was noted; cul-de-sac already contained pus. Joint washed thoroughly with saline followed by ether. Longitudinal incision on outer side, joint opened and foreign body removed with débridement. Joint washed again. Synovial membrane closed on both sides with interrupted catgut; capsule closed; silkworm gut at angles of both wounds, centers left open and Carrel gauze inserted. Cabot splint slightly flexed. No postoperative swelling, no fever, etc.

April 14. —1 : 5 fields, culture-diplococci. Delayed primary suture on basis of smear and culture.

Primary union, motion good on evacuation, May 9, one month.

Case V (April 10, 1918).—Shell fragment penetrating knee-joint. Entrance outer side joint almost in joint cleft. Operation eighteen and one-half hours later. Longitudinal incision, débridement. Joint distended with bloody fluid. Fragment passed through joint and was embedded in tissues below and anterior to joint. Foreign body removed. Smears showed Gram-positive cocci 4-field. (Culture subsequently reported diplococci and Gram-positive B.) Joint irrigated with saline followed by ether. Synovial membrane closed, capsule closed. Superficial parts closed with silkworm except small area in middle of wound. Eighteen hours, no swelling, no fever, wound looks clean. Thirty-six hours, considerable swelling of cul-de-sac; pressure evacuated about 2 ounces of mucoid-like fluid.

April 14 (fourth day). Pressure evacuated same fluid.

April 17 (seventh day). No fluid comes out on pressure; little on dressing; moves knee actively.

On evacuation, May 9 (one month), walking, full flexion.

Foreign body, deep in muscles of thigh. Débridement. Culture-diplococci. Thirty-six hours delayed primary suture, success.

Foreign body in muscles of leg. Débridement. Dressed twelve hours, culture 1 to 2 fields diplococci. Thirty-six hours delayed primary suture, primary union, success. Large piece of wood in back, superficial. Excision and primary suture, success.

1. Penetrating of knee. Primary suture.
2. Soft parts thigh. Delayed primary suture.
3. Soft parts leg. Delayed primary suture.
4. Soft parts back. Primary suture.

May 21 returned to his organization. Seen on June 26, perfect condition, is on way back from front.

Case VI (April 11, 1918).—Shell fragment penetrating knee outer aspect. Foreign body retained. Operation nine hours after receipt of wound. Longitudinal incision outer side with débridement of tract, including orifice in capsule and synovial membrane. Longitudinal incision on inner side and foreign body removed and tract excised. Joint irrigated with saline followed by ether. Synovial membrane closed. Remainder of wound left open.

April 12. Inner wound smear, 0. Culture Gram-neg. B. Outer wound smear, 0. Culture Gram-neg. B.

April 15. Wounds of soft parts sutured with silkworm.

April 17. Primary union, begin active motion daily.

April 22. On evacuation good motion.

Case VII (April 17, 1918).—Shell fragment penetrating right knee. Wounded while kneeling. Entrance one inch above patella. Foreign body ½ cm., embedded in articular surface of femur. Operation eighteen and one-half hours after receipt of wound. Longitudinal incision 4 inches long in midline from patella upward. Tract excised. Joint distended with yellowish fluid (one organism to 3 fields), Gram-positive B.: Knee was fully flexed and this brought area containing éclat into view above patella. With chisel and gouge éclat and surrounding bone removed. Irrigation. Complete closure. Cabot splint.

April 23. Primary union. Flexed actively and repeatedly. Never any pain or fever; 99° highest since operation. A little feeling of fulness in and around the knee, but no distention.

Almost full mobility on evacuation, May 9. Walking without crutches.

CASE VIII (April 20, 1918).—Penetrating shell wound of left knee, bone involvement. Operation seven hours after receipt of wound. Entrance outer side of external condyle of femur. *X*-ray showed foreign body 2 cm. in diameter in external condyle of femur. Hemarthrosis extreme.

Operation. Longitudinal incision outer side, tract excised. Foreign body 2 by 2 cm. embedded in outer condyle, removed. Edges of cavity removed with rongeur and cavity well curetted and washed with saline followed by ether. Joint similarly irrigated. Articular surface of condyle partially detached as a whole, somewhat mobile but left in place. Complete suture. Cabot splint. Forty-eight hours later dressed; looks well; little fluid; can flex knee without pain.

Sixth day. No splint; to move knee. Evacuated May 9 (eighteen days) with flexion about 45°.

December 22, 1918. Flexion, 100°. No atrophy.

March 11, 1919. Slight limitation of flexion.

CASE IX (April 21, 1918).—Multiple shell wounds. Operation eleven and one-half hours after receipt of wound. Knee, head, arm, feet, thighs, legs, etc. Many small wounds over both knees.

Penetrating of right knee. Hemarthrosis. Two tracts traced and excised to capsule. Pressure on cul-de-sac evacuated much blood from joint through small opening which had escaped observation. Knee opened on inner side and edges of orifice in capsule excised; foreign body not found.

To *x*-ray room. Foreign body 4 by 3 mm. embedded in inner tuberosity of tibia only reached on extreme flexion of joint; removed; another foreign body extra-articular, left. Joint irrigated and sutured. All tracts were laid open to prevent infection of joint from extension inward.

April 24. Up to present no pain nor swelling in knee, seems to be doing well. Both knees free flexion and extension.

Other wounds débrided. Foot, extensive laceration. Débridement, 12 foreign bodies removed.

April 24. Looks well. Carrel to date. On evacuation clean granulating surfaces.

April 23. Left knee. Looks like top of pepper box with small fragments and tracts, two removed from in front of patella.

April 24. Swelling of knee, not tense. Needle inserted outer side and 70 c.c. of bloody, mucoid-like fluid aspirated. Six foreign bodies then removed from neighborhood; one into patella tendon with foul tract. Tract excised. Splint for knee. Culture of fluid aspirated showed Gram-positive non-spore bearing bacilli; few diplococci.

X-ray revealed 13 more foreign bodies scattered through the soft tissues about the knee-joint. One minute fragment is probably buried in cartilage over external condyle of femur. No further complications.

Evacuated May 14. Motion good in both knees.

Case X (June 10, 1918).—Right leg; compound fracture of tibia and fibula; penetrating wound of knee; compound fracture of internal condyle of femur; hemarthrosis; small opening on inner aspect of knee-joint from which considerable blood and joint fluid drained. Operation five and one-half hours after receipt of wound. Longitudinal incision. Excision of edges of wound and débridement. Foreign body removed. Joint irrigated with saline solution followed by ether. Wound closed; Thomas splint.

June 19. Primary union.

July 25. Seen at a base hospital; fracture united. Beginning to move knee. Should get good functional result.

Case XI (June 16, 1918).—Multiple wounds high explosive shell inner side right knee-joint, foreign body passing through inner condyle and embedded in outer condyle. Operation twenty hours after receipt of wound. Débridement. Foreign body removed. Irrigation with saline and ether. Joint closed. Soft parts left open.

Right thigh; four lacerated wounds side by side across middle

third. Femoral artery had been wounded; ligated; muscles extensively débrided.

Left thigh; wound deep and very dirty. Excision of tissues. Wound back of mastoid very dirty; débridement; foreign body removed. Right arm, perforating wound of lower third; débridement; not sutured.

Left foot badly lacerated wound, amputation.

Patient died twenty-four hours later from gas bacillus infection of right thigh.

Case XII (June 16, 1918).—Wounds, multiple, from shell fragments.

1. Right knee; foreign body in internal condyle half way between anterior and posterior extremities of its articular surface. Entrance above and to outer side of patella. Operation fifteen hours after receipt of wound. Longitudinal incision. Débridement; foreign body removed. Bone cavity cleaned with rongeur and curette; irrigation saline and ether; joint closed, soft parts sutured.

2. Foreign body embedded in upper extremity of tibia below articular surface; tract débrided; foreign body removed; bone cavity curetted; irrigation; wound closed.

3 and 4. Right leg; two foreign bodies; débridement; wound closed.

5. Right ankle; entrance anteriorly; large foreign body penetrated ankle-joint and lodged in astragalus. Débridement; bone cavity curetted; irrigated; wound closed.

6. Left elbow. Foreign body 3 by 2 by 1 cm., lodged against outer condyle of humerus and olecranon; some comminution of humerus and ulna. Débridement; foreign body removed; joint irrigated with ether and closed.

7. Laceration of left foot, disarticulation at midtarsal articulation. Carrel-Dakin treatment.

June 18. Dressing in operating room with Savariaud anesthesia. Right knee looked well, though some swelling. Right ankle; considerable swelling and tenderness. Left elbow; some redness, swelling and tenderness. Left foot (stump); Carrel dressing. Early active movements of joints encouraged.

July 11. This patient has had a stormy convalescence. The amputation stump was very tender. His nerves were pretty well shattered and for several days it was necessary to dress him under Savariaud. The stump cleared up wonderfully under Carrel but has shown Streptococcus hemolyticus. The wound of leg also shows a hemolyzing streptococcus.

July 9 (twenty-three days postoperative). Swelling of right knee. Needle introduced, outer side of patella, no fluid obtained. Needle introduced inner side and about 55 c.c. of turbid fluid obtained, after which pressure evacuated a mucoid-like substance, the consistence of a skinned grape, about 1 c.c. in diameter. Culture, no growth. Cabot splint. Temperature elevated practically since admission.

July 30. Stump wound clean. All joints primary union. Patient up and about on crutches. Uses knee, ankle and elbow without any limitation of motion. Physical condition very good.

Case XIII (June 17, 1918).—Knee; fracture patella; primary suture; gas gangrene. Secondary suture; success. Operation twenty-three hours after receipt of wound. Right knee penetrating wound by shell fragment; fracture of edge of patella; foreign body, 2 cm. long, 1 cm. in diameter, embedded in patella. Joint filled with blood. Débridement; removal of foreign body; irrigation of joint with salt solution followed by ether; primary closure.

Calf; small wound, middle third débrided, no foreign body.

Right hand; lacerated wound, comminuted fracture of fourth metacarpal; débrided and left open.

June 18. Dressing in operating room with Savariaud anesthesia about thirty-two hours after operation. Temperature, 102°; pulse, 112. Patient did not look badly. Region around incision of right knee-joint mouse colored over wide area 6 inches in all directions. On removing stitches considerable bubbles of gas. Gas gangrene smell. Wound widely opened. Joint itself distended with serum but no gas; reopened; wound edges excised thoroughly. Incision extended 6 inches upward on inner aspect of thigh and second long incision made on outer aspect of

lower part of thigh; excision of devitalized muscles. Wounds and joint irrigated with peroxide. Carrel-Dakin treatment begun. Culture, Welch-sporogenes-diplococci.

June 21. Right knee: Carrel dressing in operating room with Savariaud. No local or systemic disturbance after reoperation. Patient encouraged to move knee June 23. No pus in joint. Granulations rapidly cleaned under Carrel.

June 25. Few B. subtilis-B. Mesentericus. Secondary suture right knee. Opening into joint closed with catgut. Skin freed and mobilized and sutured without drainage.

June 29. Patient very comfortable.

July 11. Wound of knee-joint firmly closed. Gentle massage, baking and motion. Free movement of patella.

July 30. Gradual improvement under massage and hot compresses. Can flex knee to 45°. Walks without crutches.

February 7, 1919. Flexion to 90°.

March 11, 1919. Doing full duty.

Case XIV (June 17, 1918).—1. Left knee; shell wound shattering the patella into number of pieces. Operation twenty-three hours after receipt of wound. Transverse incision; débridement. Found necessary to remove fragments constituting patella. The joint irrigated and wound sutured without drainage.

2. Right knee; shell wound of soft tissues over patella. Joint not opened. Excision of tissues and wound left open.

3. Left ankle; shell wound of soft tissues over ankle. Excision of tissues and wound left open.

June 18. Dressing; left knee distended. Right knee distended, Carrel dressing begun.

June 21. Splint removed from left leg; patient encouraged to bend knee.

June 26. Most of sutures removed. Patient upon crutches. Wound clean. Swelling has subsided.

June 28. All sutures removed, wound clean. Patient can bear weight well and flex knee 30°.

July 11. Patient has improved; can walk without cane. No pain. Flexion 45°.

January 22, 1919. Limited movement of left knee.

Case XV (July 19, 1918).—Perforating gunshot wound outer side right patella laying joint open. Wound 6 inches long. Joint opened about 2 inches. Operation six hours after receipt of wound. Excision of wound with complete débridement. Joint irrigated with saline and ether. Synovial membrane closed with continuous catgut. Capsule closed with interrupted catgut. Wound sutured with silkworm gut. Superficial infection; wound reopened and treated by Carrel-Dakin method. Secondary suture successful. Primary union. Function not recorded.

Case XVI (June 24, 1918).—Shell wound, penetrating, of right knee, with compound comminuted fracture of patella, impacted fracture of the femur in the supracondyloid region, and penetrating wound of the joint. Foreign body had been removed from wound by patient before first-aid dressing was applied.

X-ray report; oblique fracture of right femur, lower third, with slight backward and inward displacement of lower fragments, slight overriding. Operation seven and one-half hours after injury. There was a large irregularly circular wound of entrance over the patellar tendon, extending directly into the joint which contained a considerable amount of blood. The patella was broken into three large and many small fragments, and there was a small fissured fracture on the anterior surface of the femur between the articular surfaces of the condyles, which led upward to a V-shaped fracture at their base which was partially impacted. The fracture of the femur had evidently been due to direct violence without penetration of the bone by the éclat. After débridement of the wound of entrance, the joint was further exposed by curved external incision, extending upward through the capsule, and the torn synovia and fascia were further débrided. The joint was cleansed, after removal of a number of small fragments of the patella, by irrigation with a weak watery solution of iodine, followed by ether. The three main fragments of patella were preserved, and approximated by suture of the synovia and aponeurosis in such a manner as to close the joint. The skin

wound was sutured. At the conclusion of the operation measurement of the limbs showed one inch shortening on the wounded side. A Thomas splint was applied and extension maintained. Primary healing of the wound. Fixation of joint and limb was necessitated by position of the supracondyloid fracture and fracture of patella. At the end of a month passive movements were begun. On evacuation August 6, 1918, the wound was healed; there was $\frac{5}{8}$ inch shortening and good union. At this time there was from 20° to 30° flexion. September 1, 1918, 10° flexion of knee. December 29, 1918, partial ankylosis of right knee; December 30, 1918, duty.

Case XVII (June 29, 1918).—Penetrating gunshot wound (45-caliber automatic pistol) of right knee, with comminuted fracture of patella, and fracture of lower border of external condyle. Operation after four and one-half hours. Accidental wound, ball entering over upper surface of patella, splitting it vertically, and passing backward separating a thin layer of the articular surface of the external condyle, to lodge under skin at base of condyle.

X-ray report; comminuted fracture of patella. Comminuted fracture of external condyle of femur. Foreign body present; superficial on external surface, lower third of thigh. Lines of fracture apparently do not extend into joint.

Operation. Two longitudinal incisions, one anterior, and one external. Débridement of soft parts; removal of bullet and small fragment of femur; irrigation of joint with iodine solution and ether; suture of aponeurosis and joint capsule; closure of soft parts and skin.

Continuous elevation of temperature after operation, swelling of joint and moderate pain. On June 2 sutures removed from anterior, and on June 3 from lateral skin wounds. Effusion persisted in joint, and on June 5, patient was etherized, and all sutures in capsule removed. There was infection of the synovial membrane, in addition to the soft parts. Two or three small fragments of bone were removed from the external condyle. The joint was irrigated with ether, Carrel tubes inserted, and a

Thomas splint reapplied. Culture from joint and wound showed streptococcus and staphylococcus. There was a moderate irregular elevation of temperature for a couple of weeks, the wound gradually cleaned under Carrel treatment, the general condition remained good, and the bacterial count was gradually lowered. The patient was evacuated August 9, the joint still open and granulating. Heard from about one month later, doing well, not yet healed. On October 4, 1918, record showed fibrous ankylosis of knee.

Case XVIII (July 30, 1918).—Perforating gunshot wound of left knee-joint, with fracture of both condyles. Operation after four hours. Wound accidentally received by discharge of rifle. Wound of entrance inner side of internal condyle; wound of exit large and ragged, at tip of external condyle. Had lost a considerable amount of blood, and a tourniquet was still around the thigh when admitted. There was paralysis and anesthesia in the distribution of the external popliteal nerve.

X-ray Report. Comminuted fracture of internal and external condyles of femur, with partial separation of external condyle; fragment displaced posteriorly. Line of fracture apparently extending into joint at internal border of external condyle. Several small fragments of bone lying free in soft tissues in close proximity to internal condyle.

Operation. Ether anesthesia, saline infusion at same time, and later intravenous saline. Long curved external incision, splitting the muscles attached to the external condyle, and elevating them from the bone, then carried across the aponeurosis, opening the joint to the outer side of the patellar tendon. Débridement of wound of exit, and partial excision of external condyle and of posterior surface of internal condyle. Wound of entrance débrided through a straight wound over internal condyle. All bone fragments removed, joint irrigated and closed, and primary suture carried out on soft parts and skin. The peroneal nerve was exposed during the operation and found undivided. The patient's condition was poor during and after operation, and later a blood-transfusion was given and followed by quick reaction.

Evacuated August 10, 1918, still wearing splint, in good condition, and wounds healed. Result as to function not known; remaining March 31, 1919.

CASE XIX (August 4, 1918).—Penetrating wound by shell fragment of right knee inner side of lower end of patella. No foreign body seen under *x*-ray. Joint fluid in considerable amount drained from wound. Operation eleven hours after receipt of wound. Complete débridement; joint irrigated with saline, then ether; synovial membrane and capsule completely closed; soft parts closed with rubber tissue drainage to the capsule. Joint infected; reopened; Carrelled.

August 13. Secondary suture by another surgeon who reported primary union. The knee could not be moved on account of compound fracture of bones of leg. Right leg; fracture of tibia and fibula. Through and through débridement. Fragments brought into good position. Case report shows that one wound, presumably the fracture, was suppurating December 15, 1918.

CASE XX (August 8, 1918).—Perforating gunshot wound (German pistol) of left knee. Compound fracture of internal condyle of femur. Wound accidentally received while examining German pistol, probably 38 caliber. Wound of entrance inner side of left knee, base of internal condyle, ragged and surrounded by area of ecchymosis. Wound of exit midline, posterior surface, 4 cm. below lower border of popliteal space. Each 1 cm. in diameter. Joint slightly swollen. No injury to tibial vessels. General condition good.

X-ray Report. No evidence of foreign body. A stellate line of fracture extending from upper edge of internal condyle downward and inward to joint surface.

Operation. Débridement of wound of entrance through internal incision, and of wound of exit through posterior incision. Partial subperiosteal resection of internal condyle. Cleansing of joint, and suture of joint and wounds.

Moderate elevation of pulse and temperature after operation. No evidence of wound infection. On August 12, wound inspected and one suture removed; no retained secretion. Slight effusion

in joint. August 13, temperature 99°, no pain. General condition good. Primary healing of wounds. Evacuated August 23, 1918, wearing splint. September 22, 1918, flexion to three-fourths full range. To duty January 17, 1919, no class.

Case XXI (August 22, 1918).—Penetrating gunshot wound (45-caliber automatic pistol) of left knee, with comminuted fracture of femur and tibia, and penetration of knee-joint. Operation five hours later. Accidental self-inflicted wound of left knee. Wound of entrance on inner side of thigh 3 inches above joint, ½ cm. in diameter, marked deformity of knee, outward bowing, and hemarthrosis. No injury to vessels or nerves.

X-ray Report. Left upper third; foreign body superficial in from skin mark, size 45 caliber American. Left femur; comminuted fracture, perforating in character, extending from 2 inches above the internal condyle, downward and outward, apparently does not pass through the articular surface of the external condyle. Left tibia; linear fracture of the external tuberosity, with line of fracture extending into knee-joint.

Operation. Two straight incisions were employed. One was on the inner side of the thigh 4 inches long, above the joint. The second, also 4 inches in length opposite to and below the knee, on the outer side. A limited subperiosteal resection of a small portion of the internal condyle was necessary, and showed that the ball had passed behind the joint at this point, while the knee was flexed, and had then perforated the outer tuberosity of the tibia from behind forward, separating a triangular portion 1½ inches in diameter, the base of which was formed by the articular surface. This was removed, a transverse incision extending forward through the capsule being added to the external incision. Joint irrigated. Internal wound closed, with deep sutures of muscle, a small rubber tissue drain to bone. On the outer side the joint capsule was sutured, the gap left by removal of the section of head of tibia being closed by turning down over it a tongue-shaped flap of deep fascia. Cultures taken from the rubber drain the day after operation showed streptococci. On August 25, two sutures were removed from the inner wound,

and a few drops of pus evacuated. Slight effusion in joint, and slight elevation of temperature only. No pain. August 27, slight temperature persists, serous drainage only from inner wound. Swelling of knee subsiding. Evacuated September 5, 1918; primary suture successful. One month later patient wrote from Base 20, reported as doing well, walking, still some stiffness of knee. To duty December 10, 1918, no class.

CASE XXII (October 20, 1918).—Perforating gunshot wound of left knee with comminuted fracture of the patella and external condyle of femur. Operation after seven and one-half hours. Soldier admitted with history that he had been wounded by sniper, while working on telegraph pole. One wound, probably wound of entrance, $1\frac{1}{2}$ cm. in diameter over middle of patella; another wound $2\frac{1}{2}$ cm. above upper internal angle of patella, of same size.

X-ray Report. Left knee; comminuted fracture of patella. No evidence of foreign body.

Operation. Transverse incision over middle of patella, embracing wound of entrance, and then curving upward along internal border of patella and quadriceps tendon, surrounding wound of exit. The outer two-fifths of the patella were comminuted, and were removed. The opening in the joint was freely enlarged by dividing the capsule and aponeurosis. An oblique fracture, splitting off the outer portion of the external condyle, with complete detachment of a portion of the cartilaginous surface, $\frac{1}{2}$ inch in diameter was present. Several fragments of bone and cartilage with much liquid and clotted blood were removed. The joint was irrigated with Dakin's solution and ether. Layer suture of synovia, aponeurosis, and capsule. Skin wound not sutured. Joint remained clean. Passive movements begun before secondary suture of wound, which was not possible until November 16, motion being rapidly regained, although there was slight limitation of flexion from light adhesions. There was considerable tension of the skin covering the anterior surface of the knee, after the successful secondary suture, and the necessary fixation during healing resulted in the reformation of a few adhesions, intra-

articular, which limited the flexion to 20°. These were easily broken up under gas on December 6, and he was evacuated the following day. Last examined December 25, 1918, was walking, flexion to about 40° and prospects good for complete functional recovery.

Case XXIII (October 22, 1918).—Penetrating shell wound of left knee, with laceration of popliteal artery, and penetration of the knee-joint. Two foreign bodies retained. Operation after eight and one-half hours. On admission there was noted a wound in the median line on the posterior surface, left leg, on a level with the lower border of the popliteal space. There was a history of hemorrhage after being wounded, which had required the application of a tourniquet, which was later removed. The posterior tibial artery could not be felt at the ankle but the anterior tibial could be detected pulsating.

X-ray Report. Left knee; foreign body 3 by 5 mm. 50 mm. under skin with patella up. Another 1 by 2 mm. 70 mm. under skin. Larger foreign body appears to be in joint between articular surfaces, at a point about midway through the articular surface of femur. Smaller foreign body is at posterior portion of joint. Both foreign bodies appear to be free from articular surfaces.

Operation. Hemorrhage recurred while patient was going under anesthetic, and required the application of a tourniquet to the thigh for its control. A longitudinal incision was made in the midline popliteal space, and an opening in the popliteal artery 10 by 2 mm. uncovered. The artery was ligated. The smaller foreign body was found beneath it and removed. A perforation was found in the posterior ligament of the joint. The joint was then opened by anterior incision, and found to contain a considerable amount of blood. Careful and prolonged examination failed to disclose the second fragment, although ample exposure was obtained by cutting the external lateral ligament, and by partial excision of the external semilunar cartilage, and it was finally decided that it was imbedded in the crucial ligaments, and in view of its small size, might be left. The joint was irrigated, filled with ether, and capsule sutured, the skin wound not closed.

No infection of the joint occurred, although the soft part wounds showed cocci in pairs and chains on count and culture. The circulation in the foot remained good, although the surface temperature was reduced for a time. Motion was begun after two weeks. Secondary suture was not made until November 26, when two negative cultures having been obtained, a complete closure of the posterior and a partial closure of the anterior wound were successfully performed. There was a tendency for contraction of the popliteal wound, which required the application of weight extension for a time. Flexion was unrestricted, and the patient was evacuated December 12, 1918, with excellent prospects for functional recovery. Remaining March 31, 1919.

Case XXIV (November 11, 1918).—Perforating gunshot wound (machine gun) of right knee, with comminuted fracture of patella, and of condyles of femur, and division of popliteal artery and vein. Wounded while leading attack on machine gun nest on the afternoon of November 10. History of primary bleeding which did not require application of tourniquet. A Thomas splint had been applied soon after, and was in place on admission. Foot was cold, blanched and anesthetic, no voluntary movement of ankle or toes, tactile sensation preserved, plantar reflex not present. General condition fair. Blood-pressure, 110; pulse, 100. Anterior and posterior tibial arteries not palpable. Wound of entrance over patella, small and punctate; wound of exit inner margin of popliteal space below condyle $1\frac{1}{2}$ by $2\frac{1}{2}$ cm. in diameter. Very marked hemarthrosis. Shortening of limb slightly over 1 inch. Tense swelling of leg to below middle of calf. Surface temperature of leg preserved.

X-ray Report. Right knee; comminuted fracture through both condyles of femur; comminution of patella and bearing surfaces.

Operation (eighteen hours after receipt of wound).—Incision and débridement first made in popliteal space, through long longitudinal incision, exposing extensive ecchymosis of subcutaneous tissues, and a large clot in the popliteal space, the removal of which was followed by profuse hemorrhage. A

tourniquet was applied, and the débridement continued. The popliteal artery was found completely divided, and the vein widely opened. Both were ligated. The internal popliteal nerve was contused but not divided. No evidence of infection. The joint was opened widely, and a T fracture of the femur found, as shown in the *x*-ray, with posterior displacement of the lower end of the shaft. Fragments of bone removed, with a portion of the end of shaft. Anterior incision opening joint, débriding wound of entrance and splitting quadriceps tendon, with partial division by right angled incision of outer portion. Subperiosteal resection of bone fragments. Articular surfaces preserved. Irrigation of joint with hot water and ether, and closure of wounds in joint. Skin wounds not sutured. Condition after operation good. Some immediate return of circulation in ankle, but none in foot. Two days later it was evident that no return of circulation could be hoped for, and that amputation for impending vascular gangrene was indicated.

November 13. Supracondyloid amputation of thigh, by antero- and postero-lateral skin flaps, utilizing previous incisions. Circulation controlled by digital pressure above. No evidence of infection. Skin flaps sutured back, and the face of the stump Carreled.

November 29, 1918. Secondary suture of stump. Wound edges excised, granulations pared, flaps dissected upward for three inches, and wound sutured after hemostasis and irrigation. Aseptic healing, and officer evacuated to Saveney, December 30, 1918. Two weeks later walking on temporary prosthesis.

REPORT OF 82 CASES OF KNEE-JOINT WAR INJURIES FROM EVACUATION HOSPITAL I, A. E. F.

WITH REMARKS ON THE WILLEMS TREATMENT BY IMMEDIATE CLOSURE AND SUBSEQUENT MOBILIZATION, AND THE MANAGEMENT OF THE SUBSEQUENT INFECTION BY DRAINAGE AND MOBILIZATIONS

By CLARENCE A. McWILLIAMS, M.D.
NEW YORK
AND
WILLIAM B. HETZEL, M.D.
PITTSBURGH, PA.

NOTHING more startling has appeared in the outcome of this war's surgical experience than the surprisingly good, final, functional results obtained by Willems in his treatment of knee-joint injuries by immediate, active mobilizations. Willems gives the following statistics in regard to the final outcome in 100 of his consecutive knee cases, 18 of which were accompanied by purulent synovitis of a virulent type, chiefly streptococcus. In the 100 cases there were no deaths and no amputations. There was one resection and two stiff joints. These are very striking results. In comparison those obtained in the A. E. F. by the use of the old-time immobilization method, even though somewhat modified by the direction of earlier motions, suffer markedly, particularly in the septic cases. The causes of these poorer results are three:

First. Incomplete knowledge of the Willems treatment, or fear of possible experimentation. It should be the duty of our Medical Schools to teach this method so that it will supplant the old immobilization dogma, which should be discarded, except in

well-indicated cases where fragments would be dislocated by the motions.

Second. The insufficient number of nurses in the hospitals of the A. E. F. to carry out systematically the motions. A day nurse and a night nurse *en courant* with the method are indispensable in each hospital.

Third. Too early evacuation of the patients. A strict rule should be made that no post-operative joint injury should be evacuated within ten days of the operation, for two reasons:

A. The early jolting of transportation predisposes to infection.

B. The journey requires a splint which immobilizes the joint, leading to advanced periarticular edema and to the deposition of intra-articular fibrin, both of which make more difficult subsequent mobilizing motions. Early evacuations were the rule in the American Army.

Those of us who have seen Dr. Willems demonstrate his method and witnessed his results, and those of us who have followed out his procedures are all converts to his plan of treatment, however sceptical we were beforehand. The object of this paper is to express the hope that the Willems' mobilizing method will be applied to civil injuries to joints that better functional results may follow both in septic as well as in aseptic joint lesions.

Fractures. In 32 patients of the 82 there was no fracture present. In 8 there were simple fractures, while in the remaining 42 there were all combinations of comminuted fractures, the patellæ being fractured in 18, the femora in 29, the tibiæ in 12 and the fibula in 1.

Clean Cases. Of 73 cases operated upon in Evacuation Hospital 1, for knee-joint injuries, of whom we have final reports by the Surgeon-General's office as to infection, 57 remained clean, or 78 per cent. This is an excellent showing. Twenty-one surgeons reported on these cases, so that the results speak well for the careful technic of the operators so far as asepsis is concerned. In 70 of 76 known cases the synovial membrane was completely closed while 6 were drained into the joint.

Motions in the Clean Cases. In general one could say that Willems' treatment was not well carried out. Generally a splint

was not used, except in cases where a fracture made it imperative, but the lack of night nurses made active motions at night impossible and in the daytime the patient was left to make the motions by himself. There was no general system, even in the daytime, for forcing the patients to make active motions regularly. Even with this abortive plan, all the operators say that early motion gave excellent results, function having returned well in a short time. Then the too early evacuations stiffened the joints sometimes irretrievably. An illustration of the after-treatment, written by the operator who did 15 of these cases, is as follows: "These 15 cases were splinted from two to four days postoperative, at which time motion was begun, at first passive, then active; patient out of bed and walking at end of two weeks if contraindicating fracture not present." This is not Willems's treatment of knee-joint injuries as advocated by him. He does not use a splint even in the beginning and starts active motion (never passive) at once.

We have information from the Surgeon-General's Office as to the final results, so far as motions are concerned, in 36 of the cases which remained clean. Of these 36 patients, 9 had perfect function at discharge, or to duty, that is 25 per cent. (These are in the Table, Nos. 16, 22, 38, 40, 49, 68, 76, 81, 82). There was ankylosis in 3 clean cases, or 8 per cent. In 24 there was some motion in varying degrees, or 67 per cent. These 24 patients were not well classified as to the degree of motion, but here are the records as they appear in the reports of the Surgeon-General's office:

	Patients.
Slight flexion	1
Knee "somewhat stiff"	1
Slight limitation of flexion	2
Limitation of flexion	10
25 degrees of flexion	1
Flexion not possible beyond a right angle	4
50 degrees of flexion	2
Flexion to 90 degrees	1
Flexion to 140 degrees	2
Total	24

29 patients were sent back to duty, 25 without classification; two with C_2, one with CC_2, and one with Class A.

Infection of the Knee and its Results. We have accurate reports in 73 cases as to infection, obtained from the Surgeon-General's Office on completion of the case. Of these 73 cases, 16 became subsequently infected, or 22 per cent., that is one-fifth of the cases. Thus

Case.	Time in hours between injury and operations.	Result.
11	6½	Ankylosis.
11	4½	Amputation.
13	9½	Death from streptococcus septicemia.
15	81	No final report on function obtainable from S. G. O.
18	16	Death from sepsis.
20	16	Ankylosis.
34	11	No final report on function obtainable; remaining a patient in hospital, March 31, 1919.
42	15	Amputation.
44	4½	Ankylosis.
54	Unknown	Amputation.
66	7	Resection.
69	Unknown	No final report on function; remaining a patient in hospital, March 31, 1919.
70	Unknown	Died from pyemia.
71	Unknown	Died from septicemia.
79	11	Ankylosis.
80	11	Flexion to 90 degrees two months post operation, with dislocation of knee (reduced).

From this it appears that the average duration was ten and four-fifths hours excluding the eighty-one-hour case. Many of these patients had complicated comminuted fractures, but it is noteworthy to remark that five of these septic cases had no fracture of the bones of the joint. To sum these results up, we find 4 with ankylosis, 1 with resection, 3 with amputations, 4 died as the immediate result of the subsequent infection, 1 with flexion to 90 degrees two months after operation, 3 no report of function obtainable.

These are the melancholy results of infection treated more or less along the old lines of immobilization. Of 13 patients whose final result we know only one had any motion whatsoever in his knee, 3 had amputations, 1 a resection, 4 were ankylosed, while 4 died. These were all treated by a modified old plan, *i. e.*, with somewhat earlier motions. We should adopt the Willems treatment in these cases in order to obtain better results, since surely they could be much improved. Drainage with Willems' immediate mobilization afterward is much better than by any other method as there are no stagnant pools of pus left, since, if motions are frequent and vigorous enough, the pus is expelled as it forms. The mobilizations are intended as much for affording adequate drainage as for preserving the joint movements, and adequate drainage is what is needed to confine the infection to the synovial membrane and to prevent its spread to the cartilage and bone.

The opinion of surgeons in the Base Hospitals is that an infected knee is a very serious thing: first, for life; second, for limb; and third, for function especially. For the most part, because of the early evacuation of these septic cases, when they have arrived at the Base Hospitals, motion is already gone, due to the necessary immobilization for transportation, and once that is lost, it has been found practically impossible to regain it. Consequently there are three chief indications in these septic cases: First, adequate incisions for efficient drainage; second, active motions to be begun immediately after the operations and to be watched unceasingly that they never be stopped even for a day; third, there should be no evacuation to another hospital within ten days of the operation. At the Base Hospitals the *non-mobile* infected joints have been very difficult to handle owing to the poor drainage, many of them having extensions of their infections up into the thigh or down the leg, running septic temperatures and finally requiring amputations to save life. Cases that have come back to the Base Hospitals able and willing to move their joints (the exceptions) have done well, owing to the good drainage brought about by the motions. *These knee-joint cases should never be transported from an Evacuation Hospital to a Base Hos-*

pital within ten days of the injury. This cannot be too strongly emphasized. Dr. Willems is thoroughly imbued with the belief that many would be saved joint and limb by the treatment which he advocates. That better functional results and a larger percentage of cures are obtained by his method than by the old immobilization procedure there can be no doubt.[1]

Duration of the Injuries before Operation. From the appended figures can be gained an idea of the efficiency of the Transport Department of our army. Thus, of 61 cases in which the time between the receipt of the injury and the operation is known, 25 cases, or 42 per cent., were received within eight hours, 37 cases, or 60 per cent., within twelve hours, and 47 cases, or 77 per cent., were operated upon within sixteen hours of the receipt of the injury. There were only 9 cases received after twenty hours. This speaks volumes for the rapidity with which the wounded were brought to the hospital, considering the difficulties to be overcome. The time elapsed between the receipt of the injury and the operation is known in 61 cases, thus: Within two hours, 1 case; in third hour, 1 case; in fourth hour, 4 cases; in fifth hour, 4 cases; in sixth hour, 9 cases; in seventh hour, 6 cases; in eighth hour, 1 case. Thus within eight hours there were 26 cases out of 61, or 42 per cent., of the whole.

From the tenth to the twelfth hour inclusive, 11 cases, a total of 37 cases out of 61, or 60 per cent., of the whole.

From the thirteenth to the sixteenth hour 10 cases, a total of 47 cases out of 61, or 77 per cent. of the whole.

From the seventeenth to the twentieth hour, inclusive, 5 cases, a total of 52 cases out of 61, or 85 per cent.

Over 20 hours, 9 cases, thus: 23 hours, 3 cases; 26 hours, 1 case; 32 hours, 1 case; 40 hours, 2 cases; 55 hours, 1 case; 82 hours, 1 case.

Closure. There is definite information in 76 patients as to whether the joint capsule was closed or not at the primary operation. In 70 it was so closed, while the joint was left open in 6.

[1] United States Naval Medical Bulletin, Bainbridge, January, 1919, p. 61.

of the 70 with closed capsule, the external tissues leading down to the closed capsule were left open in 28, or 40 per cent.

Ligation of Vessels. Ligation of popliteal vessels was required in 3 cases, thus, of the vein (77), death from shock; of both vessels (39), followed by gangrene and amputation; and of the artery (41), followed by good function after thirty-four days. From our observations it has been almost universally true that in war injuries ligation of both popliteal artery and vein leads to gangrene of the leg.

Deaths. Of the entire 82 patients, 9 died, or 10 per cent. The time before the operations and the cause of the deaths are as follows:

Deaths.		Time between injury and operation.
13	Streptococcus septicemia . .	Nine and a half hours.
18	Pyemia	Twenty-three hours.
19	Numerous wounds	Thirteen hours.
21	Secondary hemorrhage from thigh wound; fifteen days after operation	Five hours.
31	Gas gangrene of thigh . . .	Twenty hours.
37	Numerous wounds; shock . .	Six hours.
70	Pyemia	Duration of injury not given.
71	Septicemia	Duration of injury not given.
77	Shock	Six hours.

Nature of the Missiles. In all of the cases this information is given. From these figures is elicited the fact that the prepondering number of wounds was caused by shell fragments. Such wounds are admittedly the most poisonous because the shell before explosion usually touches the ground, carrying with it the most virulent infection. These wounds are also of the severest character because of the irregularity of the fragments in size and contour. Thus: of the 82 cases, 54, or 66 per cent., were caused by shell fragments; 26, or 32 per cent., were the result of bullets (machine guns, rifles, revolvers), while 2, or 2 per cent., were not caused by missiles but one by an aëroplane propellor and the other by a fall.

General Principles of Willems's Treatment. Preliminary Röntgen-ray examination of the joint with the object of determining the degree of fracture, if any, also the marking out on the surface of the position of the foreign body beneath. At the operation careful débridement of all the damaged tissues surrounding the wound, external to the opening in the synovial membrane, and the removal of all the hemorrhages in the fascial planes about the wound. Changing of the instruments, or re-sterilization before entering the joint. Removal of the contused edges of the synovial wound with its enlargement up and down sufficiently to do the necessary subsequent work. The joint should be kept open just as short a time as possible in order that the synovial membrane may dry as little as possible, since a dry synovial membrane seems to predispose to ankylosis. Removal of the foreign body, all clothing and loose detached bone fragments. Smoothing off of all rough bone edges. If the foreign body is buried in the bone, it is chiselled away, following the tract to its end and removing all the devitalized bone surrounding the tract. If possible, all the procedures should be performed without the gloved hands being introduced into the joint, or without touching any contacting part of the instruments to be introduced. At this stage one will determine whether there is sufficient undamaged articular cartilage left to make possible the hope of subsequent restoration of function by immediate, postoperative, mobilizing movements. The joint is then thoroughly washed out with any unirritating bland solution, such as Dakin's, or normal salt solution, followed, finally, by a flushing with pure ether, and then the capsular opening edges are completely closed with a plain continuous catgut suture either through and through, or, as some prefer, so passed that no suture appears inside the joint. Unless the effusion into the joint is frank pus, as in neglected cases, the synovial membrane is completely closed, disregarding the length of time that the injury has existed prior to the operation. The tissues external to the closed capsular wound need not be closed, however, and had better not be, if the injury has existed over twelve hours. The external open wound may be loosely

packed with gauze, wet in Dakin's solution, or Carrel's tubes may be placed in position in the wound for subsequent treatments with Dakin's solution. The important point to be emphasized is that the entire opening in the synovial membrane *must* be completely closed.

A bandage is so loosely passed about the dressing as not to impede subsequent movements.

At the time the joint is open, a culture is taken of its contents to subsequently determine the presence or absence of hemolytic streptococci which, when found, requires speedy drainage of the joint. No splint is to be applied, and this is all-important.

After-treatment. Just as soon as the patient is out of the anesthetic, he is made to *actively* (never passively) move the articulation in bed. Passive motions are painful and set up an inflammatory reaction, and later on an extra-articular abscess may be caused to rupture into the joint. The patient's hands grasp the sides of the thigh, which is lifted from the bed by muscular contractions, his heel remaining resting on the mattress. At first there is excessive fear of trying these motions, but as the pain is felt to be very slight, courage is soon established. The sooner motions are begun after the operation the less is the pain, because the periarticular structures do not have time to become infiltrated with exudate. The nurse sees that this is done every two hours, night and day, to the greatest extent possible, short of actual pain. To the faithfulness, consequently, of the nurse in following these instructions will be due the subsequent restoration of function. There is astonishingly little pain when active motions are started immediately after the operation, providing no bony fragments are displaced, in which case movements are not indicated. Patients say that if painful sensations appear during repose, the best means of making them disappear is to repeat the movements.

There will frequently occur, after the operation, a hemorrhagic effusion into the joint, upon the appearance of which motions become impossible, depending upon the amount of fluid present. This should be at once aspirated, to be followed immediately by

the resumption, as before, of the active motions, which become possible as soon as the joint is emptied of fluid. It may be necessary to aspirate the joint a number of times, a bacteriological examination being made each time to determine the presence or absence of infection. (See case No. 16 in Table.)

The patient on the second or third day is made to get out of bed and take a few steps on the joint without crutches. It is astonishing how little pain is experienced on walking, if active motions have been begun immediately after the operation, and how soon almost perfect function is restored.

Management of Septic Knee-joints from War Injuries. As soon as frank pus is evident, either by signs of inflammation or bacteriological examination, thorough drainage must be at once established by vertical external and internal incisions. The joint is washed out thoroughly with Dakin's solution at the time of the operation. Tubes had preferably better not be used at first but may be later, if drainage is found to be insufficient. When they are used, the internal ends should project just inside the synovial membrane and no further. The after-treatment is conducted exactly as in the case of non-infected joints by active (not passive) motions carried out to the point of pain. These are begun immediately after the anesthetic has worn off and are repeated every two hours thereafter, day and night. Even a day's delay will prejudice the final functional result. Walking is important because the muscular contractions compress the joint and cause a marked increase in the expulsion of pus. The patient is made to walk the next day after the operation without crutches. It is surprising how much pus will exude from the incisions after each walk. It is very important that sufficient drainage openings be made to allow for an adequate escape of the pus. These openings should be sutured just as soon as the discharge becomes serous. If the active motions are performed often enough and vigorously enough, these secretions are expelled through the drainage openings as they are formed. Drainage seems to be more thoroughly accomplished by this method than by any other, thus limiting the infection to the synovial mem-

brane and tending to prevent its spread to the cartilage and bones.

In civil injuries the results of operations with débridement, joint closure and immediate subsequent mobilization should be much better than in war injuries, because ordinarily the patient is operated upon more quickly, the infection is not so virulent, there is no transfer to another hospital, and, finally, the after-nursing should be more effectually done.

The following are the divisions of joint lesions by projectiles as made by Willems:[1]

1. *Simple traumatic hydrarthrosis* or hemarthrosis without penetration of the joint cavity. This requires immediate aspiration with no subsequent splinting. We do not ordinarily aspirate these joints early enough or often enough. Active motions of flexion and extension with walking on the knee at once should be immediately instituted. This is a radical departure from the old established immobilization, and it is quickly very successful. That the abolition of movements is due simply to the presence of the fluid is shown by the fact that movements are possible immediately following the emptying of the joint.

2. *Joint Wounds Without Injury to the Bone.* The treatment for this is outlined above in the previous part of this paper. Sometimes while active motions are going along well, there will be a sudden functional impotence. Examination will show an effusion into the joint. This must be aspirated at once, a culture being taken of this. Upon removal of the fluid active movements and walking should be made as before the aspiration. The aspirations may have to be repeated several times.

3. *Articular Wounds with Small Bony Lesions.* Among these are the perforations of the epiphysis, erosions of the cartilage, the raising up of bone fragments from the surface, and losses of deeper fragments but which are superficially small in extent. All these lesions have this in common that they leave intact the greatest part of the articular surface, and there is no great frag-

[1] Bull. et mém. de la Soc. de Paris, October 9, November 13, 1917, and January 15, 1919.

ment detached or detachable, consequently there can be no displacement by motions. The postoperative treatment is exactly like that of articular wounds without bone injury.

4. *Articular Wounds with Bony Lesions of Middling Severity.* By these we mean those in which an important fragment of an epiphysis is detached. These are the oblique transcondylar fractures. The danger in them is the dislocation of the articular line. Active, immediate mobilization should be begun at once, but in the knee walking should be interdicted for about three weeks in order that sufficient consolidation should take place to prevent displacement of the fragment. In fractures of the patella, Willems encircles the fragments with a buried silk-worm gut suture and treats them afterwards with active motions and immediate gentle walking. His results are excellent.

5. *Articular Wounds with Large Bony Fragments.* When the fracture is one of the varieties of the T-fracture, the limb must be submitted to continuous extension, mobilizations being delayed for consolidation in order to preserve the articular line.

In conclusion the authors desire to quote Dr. Willems[1] in the following summary of the rules which are essential to be followed in carrying out his method:

"Active mobilization should be begun without any delay and should be carried as far as the patient is in a condition to do it. It should be done without interruption, even to the point of fatigue. This mobilization is not painful in the true sense of the word, it is only laborious and it is necessary to compel the patient to do it, to tease him if he is lacking in courage.

"It is never necessary to add passive movements to the active movements with the expectation of hastening the process.

"Patients treated by this method never present any serious alteration of their general condition, even during the early febrile period. They never look like those who have been severely infected. They do not fear movements as do those who are immobilized. Even in purulent arthritis it is striking to note

[1] Ann. Surg., February, 1919, p. 221.

that the joint has not the excessive sensibility which an infected joint presents when it is cared for by immobilization."

The authors thank most heartily the various operators of these patients for permission to include their cases in this report. Their names are purposely not mentioned in order that this report may be entirely impersonal, the desire being to ascertain the average results. Thanks are also given to Surgeon-General Ireland, of the United States Army, and to Colonel Gibbon, Director of the Surgical Service, for permission to publish this report.

CONCLUSIONS. 1. No joint injury should be evacuated within ten days after the operation.

2. The joint should be completely closed at the operation.

3. No splint should be used except in those cases where fragments will be displaced.

4. The Willems' after-treatment of immediate, continuous, active motions should be unceasingly kept up day and night both in the aseptic and septic cases.

5. In each hospital there should be a day and a night nurse who should be conversant with the method and whose only function it should be to carry out the active motions.

DISCUSSION ON PAPERS OF DRS. POOL AND JOPSON AND McWILLIAMS AND HETZEL

Dr. Frank E. Bunts, Cleveland:

I should like to ask Dr. Pool whether there was any decided difference in the prognosis of the case in which the head of the tibia was fractured or injured by the gun projectile and the case in which the condyle of the femur was injured; also, whether in cases of subsequent effusion into the joint he had tried and had beneficial results from the use of formalin and glycerin injections. That was a method which we used with considerable advantage. I would emphasize the statement of Dr. McWilliams that the early transportation of operated joint cases is very disastrous. Those cases which we were allowed to keep at General Hospital No. 1, almost without exception, did well. In those cases which we were obliged to evacuate we had reports that suppuration occurred. It seemed to me that the disturbance caused by the transportation for some reason was very detrimental, and we came to the conclusion that if we could hide them away, not allowing them to be transported, the results were much better. We found it to be of great importance that no case of this kind be formally operated on at the clearing or first-aid station.

Dr. Jopson (in closing):

It may be well to mention the conditions under which work was carried on at Evacuation Hospital No. 1, which have already been referred to in the discussion, and the extent to which we were able to judge of our end-results. It is true that during much of the time we were located in a "quiet" area, and retained our cases under observation for a longer time than was the rule in most evacuation hospitals. It is also true that for some time before and during the St. Mihiel drive, in which we bore the brunt of the drive, surgically speaking, being designated on our side of the sector as the hospital for "severe" cases, the same rules as to evacuation and retention of cases prevailed as in other units of like character. We believe that the opportunity of observing our cases for a considerable length of time in many instances, enabled us to arrive at safer conclusions as to the value and results of our methods of treatment than if we had operated on them and then lost sight and track of them almost at once. It enabled us to form very definite views not only as to treatment of joint wounds but of the value of many other methods of treatment as well. We agree with Drs. McWilliams and Hetzel as to the value of the Willems method of early mobilization of joints after operation.

When we were able to adopt it our results were proportionately successful. In estimating the percentage of failures in this class of cases, however, it must be remembered that in some cases which would be classified as failures we took long chances in attempting to save limbs and joints, and where amputation might finally be necessary, as where a conservative operation was done in the face of a wound of the main vessels, the patient had been given the benefit of the doubt, and in such cases recovery ensued. We used blood transfusion frequently in our work, and with excellent results where the patient's poor condition was due to hemorrhage. We agree with Dr. Bunts that knee-joint wounds should be considered as non-transportable, and, as far as possible, we treated them as such. In the two deaths which occurred in our series, neither was due to the wound of the knee. One man had ten or eleven other wounds, and the second had wounds of both thighs, foot, arm and head in addition to the joint injury.

TRANSTHORACIC LAPAROTOMY

By WILLY MEYER, M.D.
NEW YORK

Access to the organs within the abdominal cavity has been gained from every conceivable direction, according to the purpose of the operation and location of the field to be attacked.

Besides the great variety of incisions in front and over the sides of the abdomen—perpendicular, transverse, curved, angular, flap—we have learned to reach appendix and gall-bladder, cecum and colon simultaneously with operations on the kidney; uterus and appendages through the vagina; rectum and sigmoid from the sacrococcygeal region. The favored route for the opening of a subphrenic abscess has been through the complementary pleural space, with the help of rib resection and incision through the diaphragm.

In cases of injury to organs in the vault of the diaphragm—convexity of liver, spleen, cardiac portion of the stomach—the injury occurring by way of the chest, it has been found best to have the incision follow the course of the injury; that is to say, after performing thoracotomy and attending to the injuries inflicted on the intrathoracic organs, the surgeon deliberately incises the diaphragm or enlarges the visible wound in the same and deals with the abdominal organs as the case may demand. (Transthoracic (also transpleural or transdiaphragmatic) laparotomy.)

Ferdinand Sauerbruch was the first to proceed systematically along these lines. Standing on the firm ground of the employment of a differential pressure apparatus, he carried thoracotomy

to its logical conclusion in these cases. He reports three emergency operations of this kind:[1]

CASE I.—Compression of thorax; no external lesion. Increasing serious symptoms demand operation. Intercostal incision (7th) under differential pressure, shows rupture of lower lobe of left lung. Incision through diaphragm. Large effusion of blood; pedicle of spleen torn; splenic vein bleeding. Extirpation of spleen. Suture of diaphragm and lung; closure of chest. Recovery.

CASE II.—Young man with shot wound of thorax, right side near middle line, at level of costal arch, demanding prompt intervention. Intercostal incision (6th). Wound found in middle and lower lobe of lung, also of pericardiophrenic artery and in diaphragm. Suture of lung wound; ligature of bleeding vessel. Division of diaphragm. Liver torn at convexity. Tampon left in latter and conducted outward through abdominal stab. Suture of diaphragm and thoracic wound. Recovery.

CASE III.—Shot wound in left seventh intercostal space. Abdominal muscle spasm gave indication for thoracotomy, in the course of which the diaphragm had to be split and the injured organs within the thoracic and abdominal cavity were attended to. Recovery.

Sauerbruch lays stress upon the necessity of dividing the diaphragm in a direction transversely, or at least obliquely to the direction of its muscular fibers—*not parallel* with the same—in order to avoid injury to the phrenic nerve, which would paralyze the diaphragm on that side.

A further case belonging to this group was reported by Kenneth Bulkley before the Surgical Section of the N. Y. Academy of Medicine, in November, 1916.[2]

Stab Wound of the Chest and Diaphragm; Thoracotomy; Laparotomy; Packing of Punctured Spleen; Recovery. Boy, aged fourteen years, stabbed in left lower chest with a knife, one-half hour

[1] Trans. of German Congress of Surgeons, 1912, i, p. 142.

[2] Report of Meeting of November 3, 1916, New York Med. Record, January 27, 1917.

before admission. Through the wound, one-half inch in length protruded a bit of omentum. Resection of ninth rib. It was seen that the knife had penetrated the pleural cavity without injury to the lung, and had inflicted a wound in the diaphragm through which the omentum prolapsed. The omentum was amputated, the stump reduced and the rent in the diaphragm closed. Pleural drainage. Twelve hours later signs of peritoneal irritation and intra-abdominal hemorrhage. On incising the abdomen it was found that on the diaphragmatic surface of the spleen was a punctured wound, nearly an inch long, still actively bleeding; packing with gauze. The drainage tube in the chest was removed after thirty-six hours, the abdominal packing after forty-eight hours, and both wounds healed practically per primam. Patient was presented in good condition one week after the injury.

In January of this year, I had occasion to do a transthoracic laparotomy on a patient who had been wounded about six weeks before his admission to the hospital with the chest wound firmly healed. As the case presents a few features of interest, I shall report it in full:

J. G., an Italian, aged thirty-one years, was accidentally shot on November 29, 1918, with a 32-caliber pistol. The bullet entered just above the external condyle of the right humerus and passed through the tissues of the arm, without injury to the bone, bloodvessels, or important nerves, although the point of exit corresponded to the inner (bicipital) sulcus. It then entered the thorax in the sixth intercostal space, in the anterior axillary line, fracturing the seventh rib (Fig. 1). There was no exit of the bullet. The man was admitted to one of our city hospitals and recovered without operation and without serious symptoms. He claims to have coughed some blood during the first days, but definite information regarding this point could not be obtained.

Not long after his discharge from the hospital, he consulted Doctor Carlo Savini, of New York, who had a stereoscopic *x*-ray picture made. This showed the bullet seemingly in the lowest portion of the right side of the chest, most likely within

the lung (Fig. 2). Doctor Savini very kindly referred the patient to me for an opinion regarding indication for removal of the bullet by operation. The man seemed to be in excellent condition and

FIG. 1.—Shows entrance of bullet in arm and chest (sixth intercostal space). Inset at upper left-hand corner: The bullet which was extracted from the liver; actual size.

had no special complaints, excepting now and then drawing sensations in the region of the injury.

According to formerly entertained views, expectant treatment was here in order. If no untoward symptoms developed, the patient might carry the bullet for life. Some of our best surgeons with wide experience still adhere to this view at the present time. In rendering my opinion I tried to consider the patient's future.

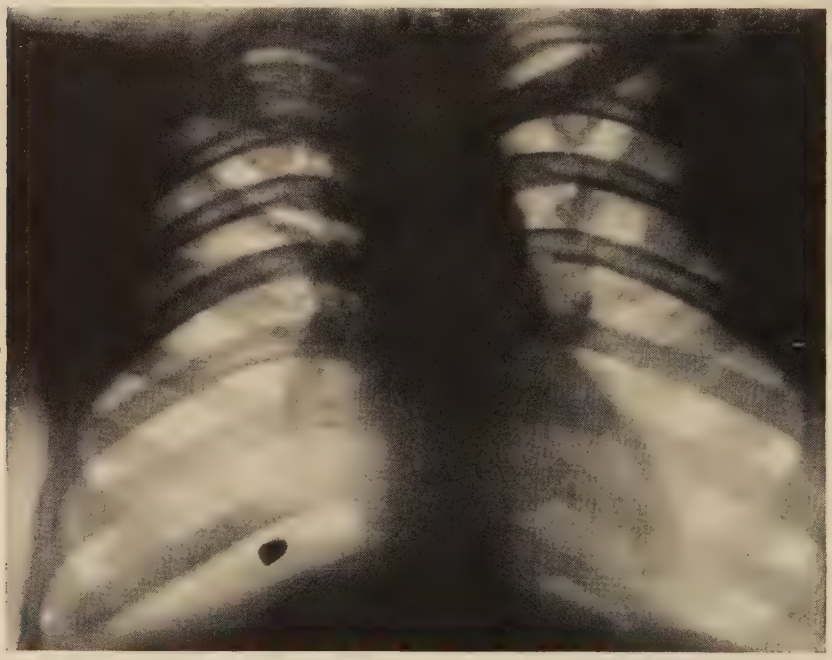


Fig. 2.—Radiograph, showing bullet in lower portion of right chest.

It seemed to me, if the bullet was in the lung the case might well be placed on a level with an interval appendix operation, demanding a prophylactic interference in order to avoid more serious consequences. I considered, that an exploratory thoracotomy done at this time—with the bullet within the lung tissue—might afford a chance of finding and removing it. Such an operation certainly involved less risk to the patient, than a possible future

suppuration within the lung; and should the bullet be found within or below the diaphragm, conditions encountered during

FIG. 3.—Shows the immediate effect of insufflation of oxygen into the peritoneal cavity. Note the pronounced dropping away of liver and spleen from the diaphragm. (Reproduced here by courtesy of Dr. W. H. Stewart, of New York. See Annals of Surgery, July, 1919, p. 96.)

the operation would have to be the guide as to further procedure. Besides, I remembered that excellent remark of Sir Berkeley Moynihan's: A bullet in the body is two bullets, *i. e.*, one in the respective organ, the other in the patient's mind. I advised operation and, with Doctor Savini's consent, had the patient admitted to the Lenox Hill Hospital. Before proceeding, another stereoscopic radiograph was taken and the patient repeatedly examined fluoroscopically by Dr. W. H. Stewart, the radiographist of the Lenox Hill Hospital; but the bullet could not be definitely located. The report reads:

"Fluoroscopic, combined with serial roentgenographic examination of the right chest reveals a bullet located between the tenth and eleventh ribs. Under the fluoroscope we noted that the bullet would rise and fall with the diaphragmatic movement. I am suspicious, therefore, that it is lodged within this muscle, or in close relation to same. It lies well posteriorly."

No matter whether in this case the bullet was situated within the lowest portion of the inferior lobe of the right lung, or within the diaphragm, or below the same in the liver, it was evident that it could be reached with safety only by way of the chest, not by way of the abdomen.

Operation (January 8, 1919).—Intratracheal insufflation (Doctor Muehleck). Incision in right eighth intercostal. Contrary to expectations, an absolutely free pleural cavity was entered; only the inner aspect of the lower lobe of the lung was firmly adherent to the diaphragm. In view of the experience had by our colleagues in the war, I had first intended not to prepare for the emergency use of differential pressure, but to make a simple intercostal incision expecting to find far-reaching adhesions. Now I felt happy, that I had prepared for and was ready to meet the emergency. There is no doubt, that without a differential pressure method already in action, the patient would have suffered an acute operative pneumothorax with its possible consequences, until positive or negative differential pressure could have been applied to relieve the situation. The thorax having been incised, with the apparatus in action, no annoying symptoms

occurred. The lung was allowed to collapse somewhat. Careful palpation of the lower lobe failed to find the bullet. A small round scar in the diaphragm seemed to point to its penetration by the bullet. Turning the palm of the hand and going carefully over the lower diaphragmatic vault, the bullet was palpated posteriorly to the central convexity of the diaphragm, quite a distance from the sternal aspect, and to the left of the median line.

The question now was: Should I continue the operation and remove the bullet?

On the day preceding the operation I had met one of my colleagues at the hospital who has seen considerable active war service. We discussed the case. He condemned operation. "One ounce—more or less—of lead in the body would make little difference," he said, "whereas the operation as planned, might prove serious, if not disastrous to the man." My conscience then began to plague me. I did not want to do an operation without definite indication, but I also thought of the two points mentioned above, particularly Moynihan's words, and therefore concluded to adhere to my decision to do an exploratory thoracotomy and, if necessary, pneumotomy. Now, suddenly faced with the fact that the bullet was not in the thorax at all, but was probably embedded in the liver, I found it difficult to decide whether to go ahead, or let the patient take the chance of having a subphrenic abscess developing later on.

Next to me, watching the operation, stood my old friend, Doctor De Vecchi, of New York, for whose good judgment I always have had the highest regard. I asked him for his opinion and he said: "Doctor, you have done a big exploratory operation; you are down upon the bullet; go ahead." And then he repeated Moynihan's words which we had discussed before beginning the operation. Although I hesitated for a moment as to whether I would be doing the best for the patient, I saw the correctness of Doctor De Vecchi's opinion and started to divide the diaphragmatic vault six to seven inches below the level of the chest wall. This proved no easy matter, partially on account of the depth,

partially on account of the continuous motion of the field of operation. To steady it with stick-sponges seemed impossible. With a straight, long bistoury the abdominal cavity was entered by an incision about $2\frac{1}{2}$ inches long. Quite some arterial hemorrhage from the diaphragm was encountered, but a clamp placed on either side of the phrenic wound nicely controlled it. The sub-

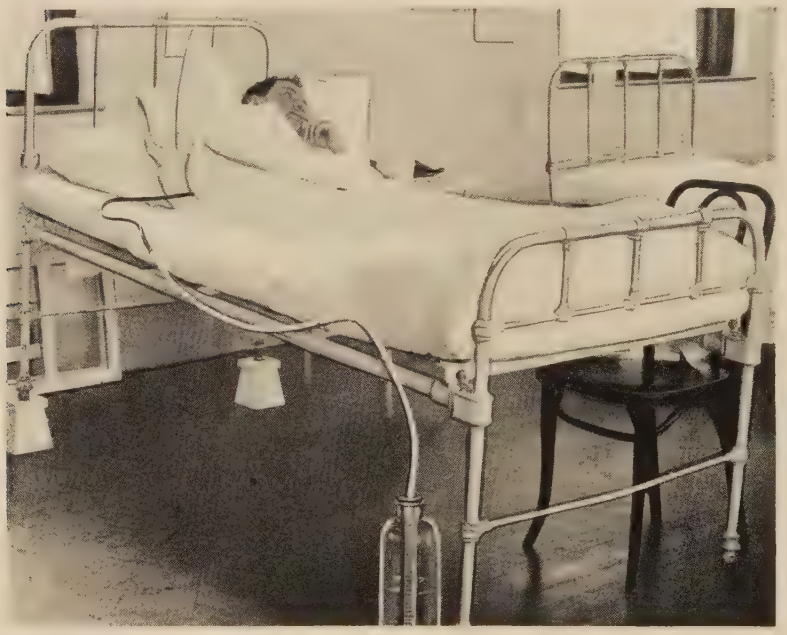


FIG. 4.—Illustrates air-tight thoracic drainage, as carried out in every case of thoracic operation under the author's care at the Lenox Hill Hospital, New York. For immediate and unobstructed inspection the drainage bottle is placed under the lower end of the bed. Patient rests on his back with right shoulder and hip supported on small pillows.

diaphragmatic space was then entered. It was perfectly free. There were no adhesions of any kind. The bullet was palpated within the liver. Again a somewhat difficult and rather delicate step in the operation followed, *viz.*, to pass the cautery through the opening in the diaphragm so far down, avoid cauterization

of the diaphragmatic wound, and then correctly incise the liver which naturally shared the diaphragmatic unrest. I did not dare enter the liver with a knife, for I had no technical chance of properly dealing with a hemorrhage. So I drew a line with the cautery through the liver substance, where I felt the bullet, and repeated this a second and third time, when suddenly pus was

FIG. 5.—When tired of one position during the time of drainage, patient can also turn on his right side, with the drainage of the right chest not interfered with (right latero-abdominal posture).

struck. A small quantity partially oozed out and partially was pressed out and caught on wipes; a culture was taken. The bullet was found and removed from the liver. It was a short 32-caliber missile (Fig. 1).

The unexpected presence of pus changed the situation and the plan of the operation. The liver wound bled slightly and was difficult of access; blood had run down into the subdiaphragmatic

space, and now, in addition, pus had been encountered. Tamponade was required. Should I treat the abdominal and the

FIG. 6.—Intercostal incision healed.

thoracic cavities separately and conduct a gauze strip, placed into the liver wound, and a second one, introduced into the sub-

phrenic space below the liver incision, out through a special stab in the abdominal wall, and then close the wound in the diaphragm and drain the supposedly infected pleural cavity? It certainly seemed the most surgical procedure. However, I considered the whole field of operation infected, the subdiaphragmatic space, as well as the wound in the liver, the wound in the diaphragm, and the pleural cavity, and, therefore, a straight drainage by means of the tampons through the diaphragm and thoracic cavity appeared more advisable, whether rightly or wrongly, I would not venture to decide; but I feared a further contamination of hitherto unhandled intra-abdominal regions. Besides, it is customary to drain the posterior aspect of the liver and subphrenic space through the lower portion of the thorax, though this is usually done after stitching the borders of the diaphragm to pleura and posterior periosteal sheath of the resected rib, thus shutting off the pleural cavity above. The wound in the diaphragm was therefore closed up to the tampons by interrupted sutures, and Kenyon's drain placed in the posterior angle of the thoracic wound. The latter was closed as usual, in layers, tightly, with pericostal chromic gut retention sutures and a continuous suture for the various muscles and the skin. The gauze drains were cut short in front of the chest, and the perforated cork, surrounding the Kenyon drain, pressed upon the same after a small piece of split gauze had been pushed underneath the safety pins, securing their ends, as a buffer. The skin surrounding the drainage region was then heavily covered with sterilized zinc ointment and a large, partially split piece of rubber dam put on top of it all, thoroughly surrounding the Kenyon drainage tube and covering the round cork-plate, through which it passes. The rubber dam was intended to act as a valve, should the gauze drains permit air to pass. The dressing was completed with dry gauze, held in place by 2-inch strips of zinc adhesive plaster, and a temporary Desault bandage, to fixate the right arm for the first twenty-four hours. The patient reached his bed in good condition. As a prophylactic measure the heart was stimulated with hypodermic injections of sodium benzoate of caffeine and

camphorated oil and the phrenic irritation quieted with morphin and atropin. The head-end of the bed was raised on blocks.

Serosanguinolent drainage in the first twenty-four hours, 250 c.c.; in the second, 35 c.c.; in the third, 30 c.c. (Figs. 4 and 5). Heart action soon became normal, but temperature fluctuated. First change of dressing on the sixth day after operation. There being no certainty that adhesions had formed to keep the lung distended throughout, the precaution was taken to change the dressing with the help of the positive cabinet. The two gauze drains in the liver substance and subphrenic space were removed without difficulty, giving exit to a small amount of sero-sanguinolent fluid; Kenyon's drain was left *in situ* undisturbed and the dressing covered and secured as at first. Some retention of sero-sanguinolent fluid was found in the skin wound and drained. The temperature in the evening of the same day was 103.2°; pulse strong and quiet; general condition good. Kenyon's drain was removed and exchanged for a small sized rubber tube two days later. After repeated dressings the tube could soon be removed. The patient made an uneventful recovery (Fig. 6).

The foregoing rather extensive description of the operative experience has seemed permissible, in view of the pus, so unexpectedly encountered in the liver, evidently representing a beginning hepatic abscess. It at once changed the entire aspect of the operation as well as of the after-treatment. Although the serological examination of the culture taken proved the pus to be sterile, the only advisable procedure at the time of the operation, in view of the unknown character of the pus, was: *drainage.*

The previous transthoracic laparotomies for liver or spleen injury in the vault of the diaphragm had been made soon after the accident, and before suppuration could have set in.

The diaphragm has also frequently been split in the course of thoracotomies, which were done in cases of esophageal and cardiac carcinoma in order to reach and deal with the diseased portion of the stomach. But there again, the rent could be sutured immediately afterward, closing the abdominal cavity, and drainage was not indicated.

No doubt, during the war, surgeons have often been called upon to enter the abdomen through a chest wound, the course of the injury demanding or inviting such an advance. It is to be hoped that they will publish their experiences. Conditions found in such cases are somewhat different from those in the case related here, inasmuch as in the war injuries the chest had been open for some time, and the question of avoiding the deleterious effects of the operative and postoperative acute pneumothorax did not have to enter the surgeon's deliberations.

After the operation, related above, the question came up whether the seat of the bullet in lung, diaphragm, or liver could have been properly diagnosed before operation.

According to a communication made by Doctor Stewart before the American Association for Thoracic Surgery at its Second Annual Meeting at Atlantic City, June 9, this year, a differential diagnosis as to the location of this bullet might have been possible roentgenographically, after establishment of an artificial pneumothorax and insufflation of oxygen into the abdominal cavity. Doctor Stewart has taken up the latter procedure on a larger scale, as the first in America, in conjunction with Dr. Arthur Stein, of New York City, Associate Gynecologist to the Lenox Hill and Harlem Hospitals, the method having been proposed and tried by Lorey, of Hamburg, and Weber, of Kiew, seven and six years ago (respectively), and having been discussed in literature repeatedly in the course of the last years.[1] Doctor Stewart's radiographs, showing the effect of oxygen insufflation into the peritoneal cavity with reference to bringing out details, are beautiful and convincing (Fig. 3). His article was published in the July, 1919, issue of the *Annals of Surgery*.

The conclusions that could be drawn from this case and the other transthoracic laparotomies on record are the following:

1. Recent wounds which have entered the abdomen through the chest and have likely seriously injured one or more of the

[1] See E. Weber: Fortschritte auf Sem Gebiete der Roentgen strahlen, vol. xx, 5, 1913, and Goetze, München. med. Wchnschr., November 12, 1918.

principal organs situated within the vault of the diaphragm are best promptly explored with the help of a transthoracic laparotomy.

2. Injuries to the convexity of the liver or upper pole of the spleen, without previous penetration of the chest, if not satisfactorily accessible from below, can be thoroughly attended to by the surgeon if he follows the transthoracic route.

3. The experience gained in general in the last war would seem to hold good also for bullet wounds of the convexity of the liver inflicted in times of peace, *viz.*, to remove the missile and therewith eventually avoid more serious consequences to the patient later on.

4. Whether the operation should be done immediately after the accident or later depends upon the seriousness of the concomitant symptoms of the patient. If a prompt, transdiaphragmatic attack is not made imperative by increasing symptoms of pressure-pneumothorax or severe internal hemorrhage, a secondary operation may be best for the patient.

5. These operations are best done with the help of some differential pressure apparatus.

6. In case the necessity of leaving tampons within the abdomen arises, it appears best, from a surgical standpoint, to deliver them through a special abdominal stab. The diaphragmatic wound can then be sutured, and thus the physiologic separation of thoracic and abdominal cavities be reëstablished.

7. Temporary air- and water-tight drainage of the chest appears here, too, to be the safest procedure for after-treatment.

8. The establishment of an artificial pneumothorax and oxygen insufflation into the abdominal cavity bid fair to make the roentgenologist able to definitely localize the seat of the bullet if it be found near the diaphragm.

DISCUSSION

Dr. Francis T. Stewart, Philadelphia:

I should like to ask Dr. Stewart how he injects the cavity of the abdomen with oxygen?

Dr. William H. Stewart, New York City:

In attempting to localize the bullet in this case, we had considerable difficulty in ascertaining whether the projectile was located in the lower lobe of the right lung, embedded in the diaphragm or had passed through the diaphragm into the liver. Fluoroscopically it was seen to rise and fall with the diaphragmatic excursions. There were no evidences of pleural adhesions. It was suggested by Dr. Howard Lilienthal, of New York, that the lung could have been excluded by producing an artificial pneumothorax; the bullet, if in the lower portion of the lung, would have receded from the diaphragm with the pulmonary collapse.

It occurred to us that the question of whether it was in the diaphragm or beneath in the liver could have been ascertained by inflating the peritoneal cavity with gas or air, the liver being separated from the diaphragm by the pneumothorax. Dr. Arthur Stein, of New York, called our attention to the literature on the subject. It was found that a number of men on the Continent had reported the results of roentgen examination of the abdominal contents after intraperitoneal inflation with oxygen, but so far as we could ascertain it had never been attempted in this country.

In conjunction with Dr. Stein, who inflated the peritoneum with oxygen, we have examined about twenty-five cases, and the results were somewhat startling. Not only did we find that the diaphragm completely separated from the liver and that we obtained a detail of the liver that had never before seemed possible, but in addition we succeeded in accurately outlining the spleen with its pedicle, both kidneys and under special technic obtained shadows of the uterine appendages. In one case we were able to detect a chain of enlarged mesenteric glands. Intraperitoneal adhesions, especially involving the anterior abdominal wall, were easily shown. It was thus demonstrated that this work opened up an entirely new field for investigation, particularly of the parenchymatous abdominal organs, the possibilities being almost unlimited.

The technic required for the inflation is extremely simple. As a rule a point on the anterior abdominal wall, about one and a half

inches to the right or left and below the umbilicus, is selected and the skin is thoroughly scrubbed and sterilized with iodin. If adhesions are known to be present or an abdominal scar is visible it is well to keep away from this area. After the skin has been anesthetized an ordinary lumbar puncture needle is passed through down to the facia. Here we pause for an instant, then the needle is gently pushed through the fascia and muscle into the peritoneal cavity. The shaft of the needle is now withdrawn and a small piece of rubber tubing is slipped over the end of the needle, the other end of the tube has been connected with a large rubber bag (such as is used in gas anesthesia), which has been inflated with about four liters of oxygen from an ordinary tank. By gentle pressure the oxygen is forced into the peritoneal cavity; the amount required depends entirely upon the condition of the anterior abdominal wall. Sufficient oxygen should be used to render the abdomen dome-shaped in appearance. The patient usually complains of a sense of fulness from the distention, and may have some pain in the shoulders, especially the right; this is probably caused by pressure on the diaphragm. The tube is now disconnected, the needle withdrawn and the site of the puncture covered with a small piece of adhesive plaster. Slight pain and discomfort usually lasts from one to two hours, so that it is not well to attempt the roentgen examination until the patient is absolutely quiet, about three or four hours after the inflation. Up to the present we have not attempted any sterilization of the oxygen. It is usually absorbed in from twenty-four to forty-eight hours.

The two factors that must be considered in the use of this method are the danger of infection and the risk of puncturing the intestines. The first can be overcome by the ordinary precautions. Regarding the second objection, we feel that with care there is absolutely no danger of puncturing the intestines. In our series of about twenty-five cases we have never experienced the least difficulty. It has been demonstrated that with a needle passed through into the abdominal cavity of a live rabbit the intestines would always recede, and the moment that the rabbit died puncture would occur. This characteristic of the involuntary muscle fiber is also practically shown by the frequent passage of an open safety-pin through the gastro-intestinal tract. We have never known of a puncture of the intestines occurring in a paracentesis of the peritoneal cavity when ordinary precautions were used.

THE TREATMENT OF GUNSHOT WOUNDS OF THE CHEST

By ELLSWORTH ELIOT, M.D.
NEW YORK

The symptoms of gunshot wounds of the lung, in those who survive the initial hemorrhage, need no special description. Here, as in other parts of the body, the development of subsequent infection depends largely upon the nature of the wound. In civil surgery, perforating wounds in which the missile escapes, and penetrating wounds in which the missile lodges in the lung, frequently heal without incident. In war surgery an equally satisfactory course may be expected in corresponding wounds the result of machine-gun bullets. On the other hand, fragments of high explosive shells, the cause of many pulmonary wounds, are frequent carriers of infectious material which may or may not be removed in the act of penetration by contact with the soft tissues of the chest wall. In all varieties of gunshot wounds of the chest, whatever the type, but more especially in those due to a high explosive agent, an associated hemothorax materially increases the likelihood of infection, for the resistance of the patient is diminished by the actual loss of blood, usually amounting to between one and two liters, and by the respiratory and circulatory embarrassment which result from the pressure of the pleural contents on the lung and heart, while the clotted blood itself provides a favorable culture medium for whatever pathogenic organisms may have been introduced.

All of the cases reported in this paper were complicated by a hemothorax which required either aspiration or thoracotomy,

and the selection of these cases was made because of the belief that, of all chest wounds, in this particular group, if in any, radical rather than conservative treatment would seem to have been justified. They would appear, therefore, to serve most appropriately as a basis for the discussion of the relative value of these two methods of treatment.

For the purpose of such consideration, these wounds may conveniently be divided into perforating and penetrating. In the former group, an expectant plan of treatment has proved, in the opinion of all surgeons, more desirable than radical measures. Four cases of this character, herewith reported, required aspiration of the associated hemothorax. This was done forty-eight (two cases) and seventy-two (two cases) hours, respectively, after the receipt of the injury. The amount of blood removed varied from an ounce and a half to one and one-half quarts. The relief of subjective and objective symptoms, indicative of circulatory and respiratory embarrassment, was generally immediate and satisfactory. In Case IV, the relief of dyspnea and pain through the withdrawal of only one ounce of blood would point to pleuritic reflex irritation rather than to pressure as a probable etiological factor of the symptoms mentioned. All four cases recovered and were evacuated in seven days after all respiratory embarrassment had disappeared.

Penetrating wounds include those with the lodgment of a foreign body in the pleural cavity and those complicated by the retention of fragments in the lung itself. Of the former there were several instances which are not included in this report, as in none was aspiration necessary. If the projectile is impacted in the pleural opening and can be reached in the course of the débridement of the external wound, its removal is preferable. Care must be taken, however, during the necessary dissection to prevent the accidental detachment and subsequent escape of the foreign body to an inaccessible part of the pleural cavity either by firmly grasping it with a tenaculum or by passing a needle beneath it, for it is quite like the "joint mouse" in its lack of toleration of restraint.

The removal of foreign bodies that have already reached a portion of the pleural cavity remote from the wound of entrance, should be attempted only in case they cause undue irritation or lead to infection. Their successful removal usually requires extensive exposure, a procedure which, in view of the proximity of the usually infected wound of the chest wall, may readily lead to infection of the entire pleural cavity. In this group of cases, as well as in the much more common group in which it has lodged in the lung, the surface of the fragment seems at times to have been cleansed of infectious and foreign material by contact with the divided soft parts of the chest wall, for while the extra-thoracic path of the projectile frequently becomes infected, the portion lying within the pleural cavity or the lung generally escapes.

The second and by far the most frequent group of penetrating wounds of the chest includes those in which the projectile has lodged in the lung tissue. The question of its immediate removal from this location or of leaving it undisturbed has been a subject of frequent debate.

Of the 15 cases of this character, herewith reported, in which the associated hemothorax required aspiration, 13 recovered and 2 died. Of the latter one had already developed a serious pleuritic infection prior to admission to the hospital, while the other was complicated by a pericarditis. In neither did the condition of the patient warrant intervention. Those who recovered were evacuated after the complete subsidence of all pulmonary symptoms, usually at about the tenth day, and in none before the expiration of a week. Apart from the relief of the associated hemothorax, which, in two instances, required a thoracotomy under local anesthesia on the fifth and sixth days, respectively, the treatment was conservative and the patients were evacuated with the projectile still *in situ*. The thoracotomy was done only after two attempts to aspirate had failed. In all of these cases, as in the four instances of perforating wounds, aspiration promptly relieved both the pain and dyspnea. No infection developed, although aspiration, and especially thoracotomy, done under conditions of war surgery, might easily lead to that complication.

Aspiration was usually done on the second or third day when it was evident that the circulatory and respiratory disturbances were not subsiding, and an average of from one to one and a half liters of bloody serum was removed. In one instance, after the removal of one and one-half liters of blood at the end of forty-eight hours, two additional liters of blood-stained fluid were removed five days later. In the interval there had been no indication of hemorrhage, and the character of the aspirated contents pointed to the original bleeding as the probable source of the "recurrence." In no instance was aspiration followed by a renewal of the hemorrhage, a fact that appears to controvert the theory that the removal of a large quantity of pleural contents predisposes to subsequent bleeding. To remove only a small portion of the extravasated blood in hemothorax at any one time is therefore unnecessary as well as undesirable, for repeated aspirations at frequent intervals are doubtless harmful to patients in a depleted condition who are fighting for breath and suffering from a lack of adequate circulation.

Apart from aspiration, the question of the immediate removal of the fragment from the pulmonary tissue has been, as already mentioned, the subject of considerable debate. Its immediate removal is unquestionably associated with a much higher mortality than allowing it to remain undisturbed, which may well be ascribed to a condition of lowered vitality and therefore of diminished resistance, due to one or more of the following factors. To exposure before and after the receipt of the injury; to insufficient nourishment; to the associated hemorrhage, either externally or into the pleural cavity; to the transportation to the hospital, which is rarely reached before the expiration of from six to twenty-four hours. Furthermore, the risk of an attempt to remove the foreign body is still further increased by the formidable character of the operation, which, together with the added inevitable loss of blood, is, in view of the general condition of the patient, sufficient to determine a fatal issue. Finally, the exposure of the lung, essential to the removal of a foreign body therein located, establishes a large communication with the

already infected portion of the wound in the chest wall and thereby predisposes to the extension of the infection into the pleural cavity.

On the other hand, by conservative treatment, opportunity is afforded for almost complete restoration of vitality, and if the development of infection or, later on, the continued irritation of the foreign body justifies operation, it may be done under much more favorable conditions and with much greater chance of success. Although as yet the writer has seen no publication of pathological conditions arising from infection proceeding from the retention of high explosive fragments in the lung, it is reasonable to infer that the resulting abscess would be circumscribed and that its contents would either spontaneously discharge into a bronchus or else, approaching the chest wall, would result in a localized empyema, in which event the opening of the abscess and the removal of any foreign material which it might contain could be easily and safely accomplished. As a matter of fact, several cases which followed this favorable course were observed by the writer in base hospitals around Tours.

The cases herewith reported, although small in number, indicate that immediate infection is uncommon. In one instance infection had already developed prior to the admission of the patient, and was unquestionably chiefly responsible for his death. Unfortunately none of the other patients who recovered were evacuated to any of the hospitals to which the writer was subsequently assigned as consultant, and therefore the final results cannot at present be determined. The writer has learned in a general way from those colleagues in whose care some of these patients were placed, that their further course was quite satisfactory and that the removal of the retained foreign bodies did not prove necessary. This fact strengthens the contention that pleuritic or pulmonary infection is unlikely to develop in patients who remain free from such infection for a period of ten days after the receipt of the injury. Whether infection will subsequently occur in the pulmonary tissue adjacent to and inclosing the projectile can only remain a matter for conjecture. The sus-

ceptibility of the lung to infection, as compared with other organs, presents a most interesting topic for investigation. Yielding easily, for example, to the tubercle bacillus, is it more or less resistant to other organisms, especially to those of a pyogenic character? Whatever the actual explanation, it seems reasonable to infer that, as a general rule, fragments of high explosive shells, many of which originally carried agents of infection, will remain in the lung quiescent, indefinitely.

Of the open sucking wounds of the pleura no mention has been made. The desirability of their closure at the earliest opportunity is undisputed. This closure to avoid tension should be made when necessary by the insertion into the opening of a musculo-aponeurotic flap in order that the reopening of the pleural cavity may be avoided, a condition which seriously threatens the life of the patient.

In conclusion, attention is directed to the serious character of infection attacking an entire pleural cavity and its lack of resistance in comparison with the peritoneum. One instance of this kind has already been mentioned in which, after forty-eight hours, the death of the patient occurred, and several other instances of similar infection, due to the penetration of foreign bodies, have been observed by the writer in civil practice. This condition is best treated by prompt and relatively protracted drainage at the most dependent angle of the pleural cavity, a counter-opening being made for that purpose whenever necessary.

The writer wishes to acknowledge his indebtedness to Captain Harold F. Budington, of Springfield, Mass., for his kindness in the preparation of the abstracts of the histories of these cases and for his conscientious care of the patients themselves.

CASE ABSTRACTS

Perforating Wounds of the Chest. Case I.—Machine-gun bullet from outer end of right clavicle to lower end of right scapula. Aspiration forty-eight hours later withdrawing half

a pint of serous fluid, followed by immediate relief of sense of weight and pressure over chest with improvement in breathing. Evacuated at end of week in excellent condition.

CASE II.—Machine-gun bullet from third rib anteriorly to ninth rib posteriorly on right side at a point two inches below angle of scapula. Aspiration of 6 ounces of bloody fluid forty-eight hours later on account of dyspnea and cough with bloody expectoration. Immediate relief of these symptoms followed. Evacuated in good condition at the end of a week.

CASE III.—Shrapnel wound entering upper right chest below outer end of clavicle, the wound of exit being in the back on the same side. Dyspnea and rusty sputum. Aspiration at the end of seventy-two hours withdrawing one and one-half quarts of bloody fluid with marked relief of the dyspnea. Evacuated later in excellent condition.

CASE IV.—Shrapnel wound below middle third of right clavicle, foreign body being located a short distance beneath the skin near the inferior angle of the scapula, from which point it was removed by a counter-incision; seventy-two hours after receipt of injury one ounce of clotted blood removed by aspiration, followed, notwithstanding the small amount, by relief of both the dyspnea and pain. Evacuated in excellent condition one week later.

PENETRATING WOUNDS OF THE CHEST. CASE I.—Shrapnel wound just below left clavicle near the shoulder, *x*-ray disclosing the shadow of a foreign body moving with respiration. Patient was suffering from marked shock and dyspnea. Forty-eight hours after injury, one quart of bloody fluid removed by aspiration from the left pleura followed by considerable improvement in cyanosis and respiration. These symptoms, however, together with the physical signs of fluid still persisted, the bloody expectoration becoming mucopurulent. On account of the persistence of dyspnea a second aspiration was done seven days after the receipt of the injury, removing two quarts of dark bloody serum. For two days prior to the second aspiration the patient's temperature was between 104° to 105°, thereafter gradually diminishing

to normal. Patient evacuated on fourteenth day, in good condition with only slight cough and no dyspnea except on exertion.

CASE II.—Shrapnel wound with point of entrance in left anterior axillary line two inches below the nipple, *x*-ray showing a small foreign body near the left nipple moving with respiration. There was severe coughing and dyspnea, due at least in part to mustard gas burn of face and respiratory tract. Twenty-four hours after receipt of injury withdrawal of clotted blood by aspiration. Four days after receipt of injury aspiration was repeated. As only a small amount of clotted blood was removed and both pain and dyspnea continued, a thoracotomy was done by Doctor Budington under cocain on the following day, removing a considerable amount of clotted blood and slightly blood-tinged serum, drainage being provided for a time with a rubber tube. Improvement of all symptoms with evacuation in ten days, the patient at that time only coughing spasmodically.

CASE III.—Multiple shell wounds, involving arms, legs, neck, abdomen and posterior part of chest, the point of entrance in this last mentioned site being near the lower border of the ribs in the anterior axillary line. There was intense shock with cough and dyspnea. Four days later the dyspnea was relieved by the aspiration of one quart of bloody fluid, the patient being evacuated subsequently in excellent condition.

CASE IV.—Shrapnel wound of right chest, point of entrance being in the posterior axillary line below the angle of the scapula. There was cough, dyspnea and bloody sputum. Two days after the receipt of injury, a half pint of serosanguineous fluid was aspirated with relief of both dyspnea and pain. Evacuated in good condition.

CASE V.—Shrapnel wound with point of entrance in the right posterior axillary line on a level with the inferior angle of the scapula. *X*-ray showed foreign body moving with respiration. There was marked emphysema with pneumohemothorax and constitutional symptoms of infection. On the third day one and one-half quarts of foul bloody fluid with much air were removed by aspiration. Although relieved somewhat of pain and dyspnea,

the septic condition continued unabated, the patient dying on the following day from the original hemorrhage and sepsis. In this patient an immediate thoracotomy under a local anesthetic might have proved of value. It was not done owing to the serious nature of the patient's general condition.

Case VI.—Foreign body with point of entrance in the back of the left chest penetrating both the pericardium and the left pleura, and seen on *x*-ray to move with the heart. The physical signs indicated an increasing amount of the fluid contents of both serous spaces, and forty-eight hours after the receipt of injury one and one-half quarts of bloody fluid was withdrawn from the pleural cavity. The patient was evidently progressing satisfactorily when death suddenly occurred eight hours later from cardiac failure. Unfortunately no autopsy could be made.

Case VII.—Shrapnel wound of left chest with marked hemothorax. Three days after receipt of injury a small amount of clotted blood was removed. Two days later, as marked cyanosis continued and another attempt to aspirate failed, a thoracotomy was done by Doctor Budington under cocain with immediate great relief of dyspnea and disappearance of the cyanosis. Evacuated on the twenty-seventh day in excellent condition.

Cases VII, VIII and IX present no special features of interest. In each one quart of blood was removed on the third (two) and fourth days, respectively. All recovered and were evacuated in satisfactory condition.

Cases XI, XII, XIII, XIV and XV.—These patients recovered and were evacuated, but neither the amount of blood removed nor the time of aspiration are mentioned in the history abstracts.

DISCUSSION

Dr. Howard Lilienthal, New York:

A matter which has not been mentioned, and which has been a very serious cause of bad statistics in gunshot wounds of the chest, has been a pneumonia of the opposite lung, and this pneumonia will come on whether you operate or whether you do not. I have seen fatal pneumonia follow gunshot wound in which nothing could be found to kill the patient but the pneumonia of the opposite lung. The man had had a hemothorax of the affected side which had been withdrawn twice: the first time blood being removed, the second, bloody serum. The man, however, died of pneumonia of the opposite lung. The cause is possibly similar to the condition in the so-called sympathetic anuria of the "other" kidney. In aspirating I do not use a needle but a fine trocar and cannula, to which a rubber tube is attached, so that the fluid will siphon out. If one wishes to avoid a pneumothorax it is necessary only to have the patient strain after you have finished aspirating and pinch the tube intermittently during inspiratory movements. Now submerge the end of the tube during expiration until no bubbles are forced out; then quickly withdraw the cannula and you have a lung in contact with the pleura. The *x*-ray will show little or no pneumothorax, the lung being in absolute contact with the chest wall. As to the matter of exploration, Dr. Eliot did not state what method he employed. I should like to say, however, that if a general exploration of the thorax is ever necessary it can be secured through a long seventh interspace incision. You can see every part of the chest and can work with both hands. Moreover, in closing, by everting the pleura and the intercostal tissues, you get an absolutely smooth line of pleural union. In two cases seen postmortem only a few days after operation I could demonstrate that the line of incision in the pleura was absolutely smooth.

Dr. Eliot (closing):

It was because of the apparently high mortality that conservatism was followed without exception during the entire Argonne campaign in the treatment of this group of cases in Evacuation Hospital No. 11, with results so good as to seem to render the removal of the foreign body from the lung unjustifiable, especially in view of the fact that verbal reports from different sources indicated a mortality of at least 40 per cent. in patients in which this form of treatment was practised, death on the operating table, in fact, not being uncom-

mon. We were fortunate in seeing no instance of edema or of consolidation of the opposite lung in this group of cases. Theoretically, I see no reason why this complication should be favored by the retention of the foreign body or by its removal from the lung. In the latter event its occurrence makes the eventual prognosis much more serious than in cases treated conservatively. In the absence of this complication it is scarcely necessary to emphasize that an extensive thoracotomy done shortly after the receipt of the injury must prove much more dangerous than after the lapse of a proper interval, during which time an opportunity is afforded for the restoration of the patient's vitality and consequently for the return of a condition in which serious operation can be done, if indicated, with greatly diminished risk.

THORACIC FISTULA AND CHRONIC EMPYEMA A NON-DEFORMING OPERATION FOR ITS CURE

By HOWARD LILIENTHAL, M.D.
NEW YORK

Chest-collapsing operations for the cure of sinuses following empyema are, except in rare instances, unjustifiable and unsurgical. Not only are they followed by permanent thoracic asymmetry with its train of compensatory pathology but the function of a large part of the breathing area of the lungs is practically destroyed. By these operations the attempt is made to bring the mountain to Mohammed—the immobile to the mobile—in a panicky effort to obliterate the pneumothorax at any cost.

The method here to be described will restore the lost pulmonary function and close the thoracic fistula without seriously reducing the capacity of the diseased side. Its danger in my hands has been far less than that of the Estlander, Schede, Wilms or Delorme operations and it needs but a single demonstration to convince one of its many advantages. It is not a "one-man" operation, nor is there required special skill in carrying out its technic, though a single practical demonstration is preferable to the most painstaking paper description.

The Operation. 1. *Anesthesia.* The intrapharyngeal method, while not indispensable, is of such value and is so simple that its adoption in these cases is advised. If ether is used it should be contained in a suitable bottle with two short tubes in a

perforated stopper.[1] Neither tube should extend below the surface of the liquid. A dental foot bellows, or, lacking this, a Paquelin bulb, will furnish the air current, a second tube of about fourteen French caliber leading from the bottle to the patient. Three and one-half inches from the end of this second or breathing tube there should be a mark and the tube should be inserted into one nostril not farther than this. If the nitrous oxide and oxygen mixture is used the bellows will not be needed, the force of the current being regulated by means of the cock, the gas passing through the wash bottle. The patient is first put to sleep in the usual way and the intrapharyngeal differential pressure is supplied only when it is called for by the operator. I am speaking here of chronic empyema in which old adhesions have steadied the mediastinum so there is no to-and-fro flapping, with the attendant cardiac and respiratory dangers. (In recent wounds of the thorax when no lymph deposit has formed it is necessary to employ intrapharyngeal pressure throughout the operation.[2])

Position. The patient is placed over a pillow and on his sound side in a scoliotic posture, the intrapharyngeal positive pressure aiding respiration should there be embarrassment. The hips and knees are flexed, a pillow is placed between the knees and a strap from under the table maintains the attitude, the patient being further steadied by sand pillows at each side.

The incision is in the seventh or sixth interspace and by preference should not enter the old drainage wound. It begins behind the costal angle and extends almost or quite to the cartilage. Part of the latissimus dorsi must be divided and it is well to cut between ligatures the vessels which traverse it. A part of the serratus magnus is treated in the same way. The subscapular and the long thoracic vessels are now easily seen and tied before they are cut and the hemorrhage thus controlled is insignificant.

[1] An excellent stopper with cock arranged so as to switch to ether or air has been devised by Dr. Wm. Branower, of New York.

[2] See note at end of paper.

Entering the Thoracic Cavity. The knife now divides the intercostal structures at the middle of the wound by an incision about two inches in length close to the upper border of the lower rib, taking care not to injure possibly adherent lung. This incision is now lengthened forward and backward with stout scissors until a sufficient opening has been made to separate the ribs by blunt traction, exposing enough of the interior to work safely and keep clear of the lung. The opening is then further enlarged until it is the full length of the cutaneous wound, when a powerful rib retractor—De Quervain's or the writer's—is placed in position and the ribs separated gradually as far as seems safe, usually about three inches. It is possible that the intercostal artery may now be wounded behind the costal angle, but through this large incision the vessel is easy to secure.

In these old empyema cases the chest wall is firmly fixed by fibrous tissue, so that it is necessary to divide from one to three ribs upward or, sometimes, downward, at the posterior angle of the wound; or, very rarely, upward at its anterior end, in order to expose every recess of the cavity, the skin incision being continued upward or downward from the posterior or anterior angle. The blades of the retractor can now be separated six inches or more. A second rib spreader may even be placed in the vertical part of the wound, further enlarging the exposure. In dividing these ribs it is well to use a Liston's forceps, cutting *slowly* through the periosteum and soft tissues at one stroke. The blades of the forceps are closed upon the edges of the rib, not upon its surface (Fig. 1). The vessels rarely bleed and often are not divided, though the bone is cut by the crushing force employed. If necessary, however, they may be secured by a hemostatic stitch and divided with scissors after the section of the bone. When ribs have been cut at the posterior angle of the wound, it has been my custom before closing the thorax to cut away about half or three-quarters of an inch of the anterior portion of each rib beyond the place of its division so as to prevent post-operative pain and trauma by the grinding together of the cut ends.

Mobilization of the Lung. With the rib retractor in position every part of the empyema cavity lies revealed before us. Often it will appear as if there were no lung in the chest, the entire organ being compressed into the angle between the ribs and the bodies of the vertebræ. All landmarks are usually found to be obliterated, and on wiping away the pus and loose tags of lymph the wall of the cavity is seen smooth, glistening and of a grayish color. With a scalpel an incision is now made into the visceral portion of this membrane from the apex to the base of the cavity, taking care not to wound the lung. This incision at once widens spontaneously and an attempt should be made to find the line

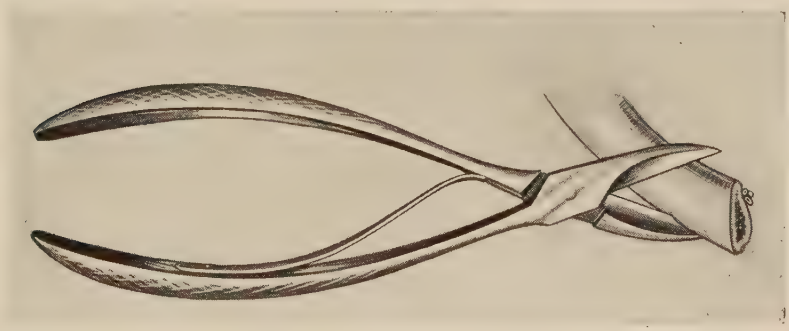


FIG. 1.—Method of dividing ribs together with periosteum and the structures of the costal groove. Note that the forceps is held so as to cut through the rib in its longest diameter.

of cleavage between the membrane and the pulmonary tissue, dissecting bluntly with instruments or finger. Second incisions at right angles to the longitudinal one will permit further expansion and the loose tags of membrane may be cut away. The anesthetist now insufflates the lung by closing the free nostril and holding the patient's lips together while the air or ether vapor is forced through the intranasal portion of the tube. If this tube is not more than three and a half inches long air will not enter the esophagus and the lung will expand, almost or quite filling the chest cavity. Fine bubbling upon its surface is no cause for alarm but a distinct hissing sound means that a bronchial

branch has been opened, an accident which in very old cases cannot always be avoided. These fine bronchial openings may lengthen the time of healing, but in my experience they have always closed without further operation. The lung, even though it has been confined for months, will nearly always yield to this treatment, but it occasionally happens that fibrous processes extend down into the pulmonary tissues so that it is impossible to peel away the membrane. Cross hatching by multiple incisions down to the lung as described by Ransohoff should then be made and sufficient expansion can usually be secured. All parts of the cavity, especially the part near the apex, should be carefully inspected and secondary pockets smoothed out into the main chamber. The adhesion of the lower lobe to the diaphragm must be treated with great care, the attenuated flat pulmonary flap being often mistaken for the diaphragm or, still worse, *vice versa*. As a rule, it is unnecessary to peel any part of the lung from the chest wall and it is unwise because of possible hemorrhage and also because the denuded part of the parietes is much more prone to infection than is the lung itself. When it is evident that no further expansion can be secured the tract of the original thoracotomy wound is well curetted and a tube is drawn through from within outward by a dressing forceps. This tube should have two perforations near its inner extremity and should extend only a short distance into the thorax. The large wound is now closed in three layers, using chromicized catgut interrupted sutures for the muscles, and silk or silkworm gut for the skin. No pericostal or percostal sutures are desirable. The ribs in these old cases do not at once fully approximate, but in drawing together the muscles an interspace of about one and one-half inches is left, and through this opening the outer wound drains into the thorax and thence out by the tube, the cutaneous wound closing by a linear scar.

When the patient leaves the table the lung will again have partially collapsed and during the after-treatment the patient must aid expansion by repeated blowing exercises. I have found that an ordinary rubber cushion or pillow with a tube attached

FIG. 2.—Diagrammatic representation of the incision seen from behind. Two rib-spreaders are being used. This is a convenience, not a necessity. One rib-spreader is all that is actually needed.

FIG. 3.—Diagrammatic drawing of anterior part of wound. Rib-spreader in position.

to its valve opening makes an excellent apparatus for this purpose. A ligature tied around the tube to stricture it forms a good resistance. The presence of a bronchial fistula greatly impedes progress, but unless it is very large it need not cause failure. In such cases Beck's paste or a 10 per cent. bismuth vaseline ointment may be injected when the wound has healed down to a sinus. Prompt closure is the rule.

After-treatment. Shock is rare after this operation and ordinarily the blowing exercises may be started within the first twenty-four hours. And after three days the cavity may be cautiously treated by the Carrel-Dakin method, injecting not more than one-half ounce of the fluid every two hours, night and day. The first sign of coughing or bronchial irritation must be the signal for the instant discontinuance of the injection, for this means that the fluid or its liberated chlorine has entered some minute and unsuspected bronchial opening. It is necessary, too, that there should be a free opening for reflux. Five or six days after the operation, vertical fluoroscopy should be performed and notes taken on the mobility of the lung when the patient coughs or strains. The discharge will gradually diminish and in five to seven days the tube may be left out. The usual time of healing is about four weeks from the day of operation. Occasionally the drainage opening will close without the complete obliteration of the cavity, as is sometimes the case when acute empyema is treated by Carrel-Dakin disinfection, and, rarely, the fistula will reopen, only to close again in a few days. The severed rhomboids and the other muscles quickly and firmly unite, so that the writer has seen no permanent impairment of arm or shoulder function (Fig. 4).

Selection of Cases Suitable for This Operation. Patients with cavities and discharging sinuses persisting for more than two months after drainage for empyema and unsterilizable by the Carrel-Dakin method should be examined with the vertical fluoroscope. Those with large rigid cavities and profuse discharge are proper subjects for this operation, which may be described as Major Non-collapsing Thoracoplasty. Small cavities when

resisting other treatment are also suitable for this form of thoracic surgery including the full exploration of the thorax in trauma, by careful two-hourly flushing with Dakin's solution for five or

FIG. 4.—Illustrating function of arm and shoulder four weeks after the operation. No counter opening was made in this case. The scar is so faint it was necessary to line it on the photograph.

six days before operating, but never should this cavity be filled—much less distended—by the antiseptic liquid. A fine tube should be employed with free space alongside, or an additional short tube should be inserted to prevent retention. The main tube may be as long as the cavity and open at the end, without lateral fenestræ. Inject slowly and always be on the lookout for symptoms of "gassing."

NOTE.—I am aware that some surgeons do not consider differential pressure a necessity in thoracic surgery. And in operating upon certain war wounds in which constant traction is made upon the lung by the operator, the mediastinum is steadied so that ordinary exploration and the removal of foreign bodies can be safely accomplished.

In old infected conditions also the positive pressure is hardly necessary except to test the pulmonary expansion; but in all other forms of thoracic surgery, including the full exploration of the thorax in trauma, in resection of lobes and in operations upon the esophagus or other intrathoracic organs, the writer is convinced that the omission of some form of differential pressure will greatly jeopardize the patient.

APPENDIX: EXTRACT OF MILITARY REPORT

Authority to publish granted Board of Publication, S. G. O. (Signed) LOY MCAFEE, Sec., M.R., Date 6–23–19.

From: Lieut.-Col. Howard Lilienthal, M. C. N. A.

To: Chief Surgeon, American E. F.

(Through Director of Professional Services.)

Subject: Report on Empyema at Base Hospital No. 101.

1. Arrived at Base Hospital No. 101, on Par. 1, Hospital Order No. 153, B. H. No. 3, July 9, 1918.

2. First examination of patients July 10, 1918. There was an "Empyema Ward" with 31 patients all having thoracic sinuses following rib resection and drainage for empyema. These were the patients remaining from a total of 44 non-tuberculous cases

operated upon in this hospital, or 70 per cent. not well after from six weeks to six months following operation.

At the time of this writing, thirty-six days after my arrival, there are only three of these cases with unhealed wounds.

Ten cases showed pyopneumothorax with sinuses, most of them with copious purulent discharge. These were selected for the thoracoplastic non-collapsing operation (Lilienthal). I demonstrated this method in three cases, the other seven being operated upon under my supervision by Caption [now Lieut.-Col.] James A. Duff, M.R.C., Chief of Surgical Service. One of the first three patients died—the only one among those operated upon by major thoracoplasty. Six patients are healed, one only three weeks after operation. The others are convalescent with excellent prognoses except one bedridden since his first operation, two and one-half months ago, and not yet out of danger.

Twenty cases with simple sinuses and pneumothorax were treated by disinfecting the cavities, and the wounds soon closed spontaneously.

One large bronchial fistula closed after the injection of bismuth paste for *x*-ray diagnosis.

3. There was blue pus in every wound in this ward, probably carried by the numerous flies, a nuisance, which, in the absence of screens and because of the proximity of filthy civilian conditions it is difficult or impossible to abate. The pyocyaneus disappeared under daily applications of iodine to the wound and Dakin's solution to the surrounding skin. Even in the presence of infection from within the chest there were but two cases in which the external operative wound had to be drained because of infection, primary union being the rule.

In addition to these ten cases, I have had ten others and three which are still under observation.

One of the latter had been operated upon three times before my own operation which was done on April 21, 1919, just two months before the present note. It was a residual empyema of the mediastinal portion of the pleura in a boy of sixteen. Bron-

chial fistula was present, greatly impeding the after-treatment. The cavity is diminishing in size, the temperature is on a low plane, although not yet continuously normal, and it is believed the patient will recover.

Two patients died. One, a boy four years old, after nine months' illness. He was operated upon on November 15, 1915, and died within forty-eight hours. Perhaps if the work had been done in two stages he might have recovered. It was a case of Staphylococcus aureus sepsis. The other death was that of a man forty-three years old with a left upper lobe chronic bronchiectatic abscess and secondary empyema. He died a little more than a month after the operation, December 4, 1914, of sepsis.

To sum up it may be stated that the procedure here described should be selected in the cases in which it has been heretofore customary to perform major chest collapsing operations or the Delorme-Fowler decortication.

There are no cases of tuberculosis in this list.

THE DELAYED OR LATE EXTRACTION OF INTRATHORACIC PROJECTILES BY THE METHOD OF PETIT DE LA VILLÉON

By ROBERT G. Le CONTE, M.D.
PHILADELPHIA

This method was developed, shortly after the beginning of the war, by radiologist Le Coniac and surgeon Petit de la Villéon at the French Naval Hospital at Brest, and since their departure the work has been continued by Doctors Corolleur and Robin, with equal success.

The method depends upon the localization of the projectile with regard to its anatomic surroundings, in contradistinction to its mathematical situation from surface markings. The localization is made through the fluoroscopic screen and not by pictures, and the extraction is also made by sight with the aid of this screen. The anatomical localization is made with the patient standing and the permanent situation of the shadow of the projectile by frontal and lateral examination will indicate its intrathoracic position. For example:

1. The displacement of the shadow downward during inspiration, following the diaphragm, and upward during expiration *i. e.*, in reverse direction to the movement of the ribs, shows that the projectile is in a freely moving lung.

2. If the shadow follows the movement of the rib, the foreign body is in the lung adherent to the rib or in the pleura.

3. When in that portion of the lung which lies in the costodiaphragmatic angle, by turning the patient there will always be a position in which the projectile will be viewed clearly between

the shadows of the diaphragm and the thoracic wall, and separate from these shadows.

4. If the projectile is in the cul-de-sac and adherent to the pleura, it will follow the movement of the ribs or diaphragm, to whichever it is adherent.

5. The projectiles on the dome of the diaphragm are localized without difficulty, but where the shadow of the foreign body is continuous with the shadow of the diaphragm, the question of anatomical localization is difficult, for it may be embedded in the diaphragm or be sub- or supradiaphragmatic. Sometimes its exact localization cannot be determined without an exploratory operation, either by the abdominal or thoracic routes.

6. When the shadow is in the quadrilateral space bounded by the internal borders of the scapulæ and the fourth to the eighth ribs, its anatomical position with regard to the great vessels and large bronchi at the root of the lung is most important. On a lateral view the hilum of the lung will be between the plane made by the anterior portion of the bodies of the vertebræ and the posterior shadow of the plane of the heart. If the shadow of the foreign body lies posterior or anterior to this space, the projectile is imbedded in the lung at a safe distance from the hilum, and may be readily extracted without danger, no matter what its depth may be from the costal margin. Above the fourth rib and below the eighth rib it is also in an easily accessible region. Extractions from the hilum of the lung will be discussed in a later paragraph.

7. In the left chest the relations of the "éclat" (shell fragment) to the pericardium and heart must be exactly determined, and if it moves with the heart beats and fails to move with respiration, extraction by means of the fluoroscope should not be attempted, and an open operation is indicated.

After the standing examination, the patient is examined lying down, to verify the information already obtained. While this anatomical localization is being made, the route by which the extraction will be made is also carefully considered, especially with regard to the tissues that must be traversed to reach the

projectile. The shortest route is not always the best, and a lateral or oblique approach is preferable, because it gives to the hand of the operator, held in a horizontal position, a greater freedom of motion for maneuvering the forceps, and permits a constantly clear view of the projectile and the end of the forceps in the fluoroscopic light.

This method depends, therefore, upon the exact anatomical localization of the projectile, and upon its extraction with forceps through the smallest of openings, in which the tip of the forceps is constantly in sight, and its guidance to the foreign body is directed by the change in relation of the shadow of the forceps and the shadow of the projectile, the patient lying on a movable table. Whichever of these objects lies nearest the tube, the larger will be the arc of its movement on rotating the patient.

To one who has not seen the method practised by a master hand, the operation may seem uncertain and hazardous. I had this feeling before making my first visit to l'Hôpital de la Marine de Brest but I left the hospital a thorough convert to the method. Later I was permitted to make some extractions of foreign bodies from the extremities. In this institution about 4000 projectiles have been removed from various parts of the body by this method. In the extremities these extractions were so easy and rapid that it led Petit de la Villéon to try it in the lung. This was done for the first time October 27, 1915, with perfect success.

Technic of the Operation. The patient is bound to a table, the surface of which can be rotated on its long axis, with the *x*-ray tube beneath and an iris diaphragm for the concentration of the light on a given point. The patient is anesthetized while the room is light. The lights are then turned off, and when the pupil has reacted to the darkness, the *x*-ray is turned on, the projectile inspected, and the point of approach noted on the skin. The light is turned on, and with a bistoury a small stab opening is made to the pleura, just large enough to admit the forceps. The point of the forceps is placed in this cut, the lights are shut off and the *x*-ray turned on. By gentle pressure the closed forceps are forced toward the projectile, and the two

shadows are correlated by movements of the table. When the "éclat" is reached it is gently freed from its bed of surrounding tissue with the closed blades of the forceps, and when completely movable the forceps are opened and the object grasped in such a manner that any existing sharp edges or points will cause no damage to the surrounding tissue during the extraction. After the removal, the pleura is carefully inspected for a moment or two for hemorrhage. The light is turned on and the wound dressed with sterile gauze. The technic is simple but highly specialized, and three things are essential for the successful practice of the method:

1. The radioscopic eye must be acquired.

2. The correlation of the two shadows made by the foreign body and the point of the forceps. This must be intuitive, without process of thought, as a dentist works by mirror or direct sight.

3. Gentleness and dexterity of the hand. This is acquired by the removal of projectiles from less dangerous zones, as in the extremities.

The principle underlying the success of this method depends on the fact that a closed forceps can be made to traverse a healthy lung without injuring the vessels or bronchi, as these important structures will be pushed aside when gentle force is used. The danger from hemorrhage will come during the extraction, when the projectile is considerably larger than the diameter of the forceps, or its cutting edges are not protected by the blades of the forceps. The passage through the lung to the projectile must be a straight one, and the making of V or Y passages must be avoided. For superficial foreign bodies, an ordinary hemostatic forceps is used, but for those lying deeply in the lung the alligator jaw forceps is preferable. The forceps should snugly fit the opening through the thoracic wall, to avoid the production of a pneumothorax, for with air in the pleura a freely moving lung slips away from the forceps. In the hands of an expert two or three minutes will suffice for the removal of superficial "éclats." Those embedded in the depth of the lung will take a little longer time.

Anesthetic. The patient is put to sleep with the lights on, but during the operation the anesthetic is continued in the dark. The French use ethyl chloride in a closed inhaler for short operations, but if the operation is prolonged beyond a few minutes they add chloroform. In the United States ether will be preferred to chloroform, but it must be remembered that it is slightly more irritant to the lung. The absence of light requires an experienced anesthetist.

The Incidents during Extraction. A little air may enter the pleura through the cutaneous opening with a slight whistling noise. Slight hemoptysis may occur, or the patient's saliva be mixed with blood. Slight hemorrhage into the pleura from the zone of extraction is not infrequently observed. It will be seen through the screen as a light shadow the size of a quarter, which may increase to the size of a dollar. This should be observed for a sufficient period of time, to be assured that a rapid hemothorax is not developing. All of these incidents in Robin's capable hands were without importance.

After Care. The patient is put to bed and given a sixth of a grain of morphin and an injection of antitetanic serum. In war wounds all deep scar tissue or embedded projectiles are potential harborers of tetanus bacilli. During the first twenty-four or thirty-six hours there is usually a slight elevation of temperature. Coughing is prevented or controlled by codein. The expectoration will be tinged with blood for two or three days. Sometimes a little subcutaneous emphysema will develop around the wound. In a week the patient is out of bed. It may then be noted that there is a slight diminution of respiratory movement, due perhaps to pleural adhesions or to pain in the region of the wound. Respiratory gymnastics should then be used. At the end of a month the patient is ready to leave the hospital.

Projectiles in the Hilum. The removal of foreign bodies from this region of the lung will always be attended with danger, no matter what method of operation is employed. The localization of the "éclat" in this area has already been described, and careful consideration must be given to the route by which the

extraction will be made. As the first step in this operation a portion of one rib is resected, and the pleura incised for an inch or more in extent. Should hemorrhage occur after the extraction, the field for controlling it with a gauze pack is prepared in this way. When the projectile lies in the posterior half of the hilum of the lung, a posterior thoracotomy is done, and after opening the pleura an alligator jawed forceps is carefully guided to the projectile under the fluorescent screen. If hemorrhage occurs, it is controlled by packing and the wound left open. If it does not occur the incision in the thoracic wall is closed by suture.

The dangerous zones from which projectiles should not be removed by this method are the mediastinum, pericardium, heart, the medial region of the diaphragm, and the left diaphragm unless the missile is clearly supradiaphragmatic. In these regions an open operation is safer, when it is deemed advisable to remove the projectile.

Statistics. During the October, 1918, meeting of the Congress of French Surgeons, Petit de la Villéon reported about 330 and Robin 92 extractions of foreign bodies from the chest. There were four deaths in these combined series, a mortality of a little less than 1 per cent. One death was apparently due to the anesthetic, and one occurred from sepsis, in a patient who had previously had an open operation on the opposite lung, and the autopsy disclosed a putrid gauze pack in the pleura. I can only analyze Robin's 92 extractions, as Petit de la Villéon's statistics are not available for the moment. The above case with the putrid gauze pack was Robin's only death. Three of his cases developed hemothorax. (1) The hemorrhage reached the level of the seventh rib, and recovery followed without operative interference at the end of a month. (2) The hemorrhage was more profuse, requiring three aspirations of 200, 250, and 800 grams of blood. Recovery followed without further incident, beyond a stay of four months in the hospital for pulmonary gymnastics. (3) A small localized hemorrhage developed into an empyema requiring a costal resection for drainage. Recovery followed in three months. One other case developed an empyema on the

twelfth day without previous hemothorax, and recovery followed the excision of a rib. The danger of purulent pleurisy is not from the exterior, as in an open operation, but from the interior, when infection exists in the tissues surrounding the projectile. That this danger is infrequent is shown by Robin's statistics. Theoretically its infrequency may be explained by the rapid closure or sealing of the punctured wound in the lung, and the draining of the infected cavity by a bronchus. Such drainage would probably be unnoted in the sputum, but that it can occur would be shown by the hemoptysis which frequently follows the extraction. It may, therefore, be an added factor of safety in the operation.

Indications for Operation. Intrathoracic projectiles should be removed when the patient complains of pleurodynia, shortness of breath on slight exertion, cough or dyspnea, more or less frequent hemoptysis, and when there are signs of congestion in the lung surrounding the projectile, with slight elevations of temperature. When no symptoms referable to the projectile exist, the question of its removal should be considered with reference to the possibility of its causing future trouble. Also, "éclats" should always be removed from a military patient, when their presence prevents him from re-entering Class A. When the projectile lies in the mediastinum or hilum of the lung, its size and the degree of tolerance must be carefully balanced with the danger of its removal. In the average case the intervention is so simple, the extraction so easy, the recovery so prompt, and the risk so small, that due weight must be given to these things when the subject of operation is under discussion.

Conclusions. 1. This method is by far the easiest and most rapid way of extracting a foreign body from the lungs.

2. It is the most certain and direct way of reaching the projectile.

3. It is free from operative shock.

4. It traumatizes the least possible amount of tissue.

5. It reduces postoperative sequelæ to a minimum.

6. The recovery is rapid and the mortality low.

It will not demonstrate fragments of clothing which may have been carried in with the projectile.

Extractions of foreign bodies from the lung should not be attempted by the surgeon until he has served an apprenticeship with an expert radiographer, has acquired the necessary dexterity of hand, and has learned to correlate intuitively the shadows of the projectile and tip of the forceps.

DISCUSSION ON THE PAPERS OF DRS. LILIENTHAL AND LeCONTE

Dr. John H. Gibbon, Philadelphia:

I would suggest that the discussion of these papers be opened by Dr. Depage, because in February of this year Professor Tuffier showed to some of us a number of very remarkable results following the treatment of old sinuses of the chest; these were very striking, and he attributed them entirely to the work of Dr. Depage. Therefore, it would be particularly interesting to us to hear what Dr. Depage says about the treatment of these old sinuses. The treatment which Professor Tuffier carried out would obviate in a large proportion of cases any operation whatsoever.

Dr. Antoine Depage (through the interpretation of Dr. Joseph Van de Velde, La Panne, Belgium):

Dr. Depage says that in the beginning, when he had a very bad case of empyema he did not know what to do with it, and then decided to try the Carrel method. Following this with the bacteriological count, as already described by him, he found that the wound became sterile. He then, after having made a culture, simply closed the wound and the result was perfect. After this all empyema cases were treated by the Carrel method without suturing, and all of them gave very good results. It is very important not only that the bacteriological count should be satisfactory, but that there should be no secretion in the wound. Dr. Depage has had several cases in which the cavity was enormous, coming up to the top of the lung, in which we could have injected 1 to 1½ liters of liquid. Before suturing the wound the edges should be freshened, then the pleura, and following that, the skin should be sutured. Dr. Depage says that in a big cavity, after suturing, very often we see under the fluoroscopic screen that liquid comes into this cavity, but that this liquid does no harm, since it just absorbs gradually. Dr. Depage says, of course, this is not a method to be used generally, because we have enough other methods by which we can treat and cure empyema. He believes that sterilizing the cavity by the Carrel method will take the place of the Estlander and Schede operations. Many of you have also seen the Tuffier operation, and those who have will be absolutely convinced of its value.

Dr. Alexis V. Moschcowitz, New York:

If there is any one subject that, five years ago, at least so far as its surgical aspect is concerned, was considered absolutely finished it is that of empyema. About that time Dr. Lilienthal took up its

study, and the discussion today proves only too well that he deserves the credit for again placing empyema upon the surgical map.

Personally, I have also been interested in the subject for a number of years. My studies, augmented by the exceptional opportunities afforded me by my military service, have led me to somewhat novel conclusions regarding empyema. In the limited time at my disposal I cannot even begin to discuss them at length. I will therefore confine my remarks to the manner in which an empyema cavity heals. Up to within very recent times we knew practically only one method of healing of an empyema, namely, by the gradual expansion of the lung, and by a concomitant process of obliteration of the pleural cavity, due to adhesions resulting from a granulomatous change in the pleura. This may therefore be called the "classical" method of healing.

A second and more decidedly recent method is that proposed and carried out by Tuffier and his followers, which is based upon the fact that many empyema cavities can be rendered sterile by means of the Carrel-Dakin treatment, and when sterile the drainage opening can be successfully closed by a secondary suture.

Finally, I have made the following highly interesting observation. About a year ago I had under my care a case of empyema which had been healed for about a month. A routine physical examination, subsequently verified by *x*-rays, revealed the startling and interesting fact that though solidly healed the patient had a closed pneumothorax, approximately the size of a fist. I watched this case with great care, and for that matter also with trepidation, as I feared a reaccumulation of pus. This, however, did not occur; on the contrary, in the course of a few weeks, the cavity disappeared and the lung expanded, and completely replaced the pneumothorax.

Prior to making this last observation, hardly a day passed but that I operated at least on one case of chronic empyema. It then dawned upon me that it may perhaps be possible to imitate nature in one of her methods of healing. Since that time all of my endeavors culminated in that direction, namely, to sterilize the cavity by the Carrel-Dakin method, and when sterility has been maintained for at least one week, as proved by daily cultures, to permit closure of the external wound. A closed pneumothorax results, which disappears in the course of time, with good expansion of the lung and permanent healing.

Dr. Willy Meyer, New York:

Dr. Moschcowitz's statement of Nature's healing brings back to my mind a recent experience: A baby of ten months came under

my care who had been operated on for empyema. There was a discharging sinus and a very erratic temperature. The Carrel-Dakin treatment, in the efficacy of which I firmly believe, could not be carried out because the child could not be controlled. We therefore used formalin-glycerin injections of 0.1 per cent. strength. I did not expect any favorable result from the few times I injected, but the sinus closed, much to my surprise. An *x*-ray taken at this time showed clearly a pneumothorax. The parents had had a similar experience with this child before, viz., the sinus closed and then reopened. We now kept the child in the hospital for two weeks longer; the sinus did not reopen. It also remained closed at home.

I would here like to mention another case which clearly proved the beneficial effect of the Dakin treatment. In a case in which it was desired to know the extent of an empyema cavity a colleague injected bismuth oil for taking the radiographs. While the size of the cavity could be beautifully seen, the patient developed an acute bismuth-poisoning; fortunately he did not die. I was called upon to take out, if possible, the remainder of the bismuth oil. It became necessary to enlarge the original wound resulting from the rib resection. I came into an irregular cavity, which extended up to the collarbone. A good deal of the oil escaped and the cavity was drained. The patient continued to have high temperatures when we started the Carrel-Dakin treatment. After forty-eight hours the patient was apparently in very good condition, saying that he never felt better in his life, a striking effect. The sinus is not yet closed, but is nearly so.

One word yet with reference to the treatment of real old empyema fistulas. Quite a number exist, due to a long cavity parallel to the spine, which is well shown by the *x*-ray after bismuth injection. Resection of the entire thickness of the chest wall must here be very thorough; only most radical work can bring help; but nothing is more gratifying than to cure these cases. I can show two completely cured patients of this type. I think Dr. Lilienthal did an excellent thing by using pharyngeal insufflation in these cases. It seems that sometimes, even in old chronic cases, with great thickening of the pleura, the differential pressure employed during and after the operation may save the patient. Lately I have done a complete Schede operation in a tuberculous male, and the patient is convalescing nicely. I operated on the right side. A few days ago I operated on another tuberculous empyema fistula on the left side, again using local anesthesia. After exposure of the large cavity with pericard lining the patient complained that he could not breathe. He did survive the operation, but died one hour later. I feel that if I had helped his

system by physical means, employing the differential pressure method, he might have lived.

Dr. Albert J. Ochsner, Chicago:

At the Philadelphia meeting of this Association I reported a series of cases such as Dr. Lilienthal has described in which we used Beck's bismuth paste, following his directions absolutely. I have forgotten the percentage of cases that recovered permanently as a result of this treatment, but I should say more than 80 per cent. of all cases coming under our care. Some of these cases had existed for as long as two years. The bismuth paste must be administered, however, with great care, in order to avoid poisoning and to obtain good results. The treatment should be carried out absolutely, according to the exact directions which Dr. Beck has described.

Dr. Charles A. Powers, Denver:

In reference to the excellent paper by Dr. LeConte, while at Brest, in the summer of 1918, I had the privilege of seeing this work at the hands of Dr. Robin, a naval surgeon, French, at the Maritime Hospital, and it seemed to me one of the most valuable and impressive procedures which I saw in France. On returning to my own station I recommended to our medical department at headquarters, through military channels, that an investigation be made of this work. I was told that a board was appointed, but I do not know the result of the findings of the Board. That which I saw was to me a remarkably fine piece of surgical work.

Dr. Joseph Ransohoff, Cincinnati:

We have a subject under discussion of which some of those who have not had opportunity of being in military service by reason of age have a word to say. In the influenza epidemic I had about 80 cases of empyema in my service at the Cincinnati General Hospital, 3 of them double, and all of these recovered. Nothing is more important in the treatment of chronic empyema than not to find an empyema. In regard to the sterilization of the empyema cavity by means of the Dakin solution, I trust Dr. Depage will be given an opportunity of telling us whether he saw any cases of empyema in which there was abscess of the lung complicating the empyema. This occurs quite frequently, I should say in about 6 per cent. of the cases of acute empyema. We find there is a lung abscess from the very beginning. It is a mistaken notion, I think, that all cases of empyema come from the surface of the lung. In about 6 per cent. of the cases there is in reality a subpleural abscess that is the start of

the empyema and that drains in both directions. Consequently, we have in these cases a connection between the pleural cavity which is infected and the abscess of the lung. We did not discover this in our cases until we started to sterilize with the Carrel-Dakin solution, with the result that the patient coughed up some of the solution, with complications which were rather unpleasant. There is no question but that these cases can be closed by means of sterilization and leaving some fluid there, but how long will that fluid remain absolutely sterile? We know that cases of empyema remain closed for two or three years and then open up again. As long as there is any fluid in the pleural cavity we may count on it that sometime there is a possibility of a relighting of the infection. I agree fully with Dr. Meyer that in some of the chronic cases the mere sterilization is not going to do the work. We must make a resection and get the lung free, either by Fowler's method or by what is called a dissection method, and give the lung a chance to expand.

Dr. Joseph A. Blake, New York:

It seems to me that, as Dr. Ransohoff has just said, the best treatment of the chronic sinuses following empyema is their prevention; and I believe that in too many cases drainage is continued too long after the primary operation and that the drainage tube and the treatment are responsible for the formation of sinuses. Although it may not be in direct discussion of the paper, there is another point which has been brought up in the discussion—namely, that of the treatment of empyemata by the Carrel-Dakin solution. I am positive that it is absolutely wrong to commence the Carrel treatment in the early stages of the treatment. For instance, we would not think of using the Carrel treatment with the tubes and constant irrigation in the peritoneum in case of peritonitis, nor in the knee-joint in suppuration of the knee-joint. We should no more use it in the pleural cavity in the early stages, and it has been my unfortunate experience to see a very large number of patients in France in which the Carrel tube had been left in place too long, with the result that a sinus was formed. Much judgment should be exercised at the primary operation, the same technic not being suitable for all cases. In some cases there is a great deal of solid material and exudate which must be removed. By spreading the ribs in these cases the hand can be put in and thus remove this material completely. Often in such cases the drainage tube may be left in for only thirty-six hours; after its removal the wound closes up immediately. This leads us to the same point—namely, that too much drainage is used in the early treatment of empyema. Of course, we must never lose our judg-

ment; we cannot go by rule. There are a great many cases also in which drainage is necessary but it is insufficiently established. This comes back to the old principle, that when we use drainage it should be efficient; insufficient drainage often being worse than none. It would take too long to go into an analysis of which cases should be drained and which not.

In regard to the removal of projectiles from the lung, I hesitate to say this because it is a criticism based on hearsay; a doubt has been raised in my mind and I should very much like to have that doubt removed. The Petit de le Villeon Hospital in Paris came into my hands to use as a secondary hospital in the overrush of wounded, and in talking with the director of the hospital he stated that the mortality had been very high; in fact, that the hospital had been requested to be closed on that account. Perhaps I should not bring this up because the information did not come from really medical authorities, but it made me think that possibly the mortality was greater than generally supposed.

Dr. Antoine Depage, La Panne, Belgium (through Dr. Joseph Van de Velde):

Dr. Depage wanted me to say that he absolutely agrees with Dr. Blake that the Carrel-Dakin treatment should be used only in the chronic cases.

Dr. Lilienthal (closing):

This operation in properly selected cases is the operation of choice for the reason given. If you can cure empyema without secondary operation so much the better, and I am perfectly willing to exclude for the present those cases that will probably get well with the Carrel-Dakin method. There is an old dictum that no thorax should ever be filled with fluid. There have been many cases of convulsion and death from merely irrigating the chest cavity. It might not happen often, but when it does happen it is particularly tragic. Regarding the bacteria in these cases, it is hard to tell whether you have cleaned out every part of an empyema cavity. You may make cultures and smears, but if the cavity is a sufficiently complicated one you cannot be sure you have cleaned it entirely. Nothing is easier than to close an external thoracotomy wound, and those patients who are able to take care of such infection as may be left inside will presumably get well. I had, however, one man, a Texan, operated on two years before for empyema whose sinus reopened and closed. After this he had then been taken into the army and again developed empyema. I performed this operation on him, and now I think he is well. The

operation is a truly surgical one; you can see that you have cleaned the cavity out and you know the chances are excellent for permanent recovery if they get well, and they usually do. Another man had been operated on at the hospital farther to the front than the base hospital, with which I was connected for part of the time, and he came in to be sent home. He was classed as recovered from his empyema. His temperature was normal and he was doing kitchen police work. Suddenly he developed a temperature of 102°, and just a short time afterward spat up about a quart of pus and immediately became desperately ill. I was obliged to operate and found a bronchial fistula. Recent reports showed that the man was still alive and probably would get well, but the condition was indeed a serious one. That is the second case of the kind I have seen; therefore, do not think when a patient's chest is closed that, beyond all doubt, it will remain closed.

Regarding the paste poisoning, we had one case at the Mt. Sinai Hospital in which the man died and which was fully reported in the literature. Speaking of spontaneous cures the following case will be of interest: I showed a patient before the American Society for Thoracic Surgery in whom in the right chest there was no lung. I had removed the middle and lower lobes and part of the upper, the rest of the lung undergoing atrophy. The man has been well for over a year. I wondered what had happened on the other side of the chest. I had not collapsed the affected side and there were four large bronchial fistulæ. He afterward closed up spontaneously and has been well for a good many months. Examining the *x*-ray, I found, to my astonishment, a closed pneumothorax. That shows what can happen without the Carrel treatment. The man had had no Carrel treatment on account of the bronchial fistulas. I made one attempt, but had to desist because of imminent asphyxia.

Dr. Le Conte (in closing):

In regard to Dr. Blake's inquiry, I can only say that the Petit de la Villéon Hospital reported 330 cases at the French Surgical Congress in October, 1918, with 3 deaths. Robin reported 92 cases with 1 death. We cannot question these statistics, as no one would report such a series to the French Congress if the figures were not true.

In regard to the chronic empyemas and the irrigation of the acute empyemas with Dakin's fluid, I have been timid about using fluid in the pleural cavity immediately after it has been opened, and particularly in those cases in which a bronchial fistula exists. My own practice has been to sterilize the cavity with small and gradually increasing amounts of dichloramin, as I learn the tolerance of the

pleura in the individual case. It does sterilize in the chest, I think, as rapidly as the Carrel-Dakin solution. The dressing is made once or twice daily, and the action of the diaphragm will coat the inside of the pleural cavity with the Dakin oil. I have had as rapid healing with less danger from this small amount of dichloramin as I have had from bathing the pleural surface with large amounts of the hypochlorite solution.

FRACTURES OF THE LOWER THIRD OF THE FEMUR

By JOSEPH VAN DE VELDE, M.D.

This type of fracture has always been considered one of the most serious on account of its complications, its treatment and its results. The compounding of these fractures during the War has considerably complicated the treatment. The lower fragment under the action of the gastrocnemius is regularly pulled backward; any traction on the straight limb will increase this displacement.

We divide open fractures by missiles into three different types—fractures with—

1. No comminution.
2. Slight comminution.
3. Much comminution.

We used at La Panne two or three different methods of treatment. Those methods are:

1. Wiring.
2. Traction on the femoral condyles by ice-tongs, Steinman pins or Willems screws.
3. Depage's vertical suspension of lower fragment combined with horizontal traction on the leg.

The first type of fracture produced by a bullet at long range or a shrapnel ball or small shell fragment at the end of its flight, has no or little comminution. The soft parts are only slightly lacerated. This is the ideal case for wiring. If after débridement we plan to make a primary suture of the wound we use Dr. Depage's wiring method, because the metallic tube that sustains the wire comes out of the scar and affords good drainage.

If, on the contrary, we plan to make a secondary suture we use a Parham or a bronze wire, which we remove after a month before suturing the wound. It is understood that wiring only can be used in oblique fractures. In transverse fractures we use the ice-tongs or vertical suspension, and with a few cases we have used Lane's plates with good results and without any complication. We do not, though, recommend the introduction of screws in open contaminated fractures.

The wiring method seems to us the ideal method for the open fractures of the lower third. It gives a perfect reduction, requires little postoperative attention, and permits the suspension in a Thomas or Blake splint.

In the second type we have to deal with slightly comminuted fractures; the soft parts are extensively lacerated, the débridement must be thorough, the fracture carefully explored and all loose fragments of bone have to be removed; but the continuity of the bone is assured by large adherent bone fragments, well supplied with blood. Primary suture of the wound is dangerous; therefore we always plan to make a delayed primary or a secondary suture.

Those are the cases in which we use the ice-tongs, Steinman pin or Willems screws, if a low wound does not contra-indicate their employment.

Willems screws are not to be recommended. They hold badly in the cancellous tissue of the condyle; they loosen under traction, cause pain by pressure on the skin and finally pull out after two or three weeks.

The Steinman pin seems to us the best method, the knee-joint being bent. Ice-tongs are also good. It is best to place the pin just above the condyle; unfortunately, the neighborhood of wounds prevents us very often from doing this; we have then to pass it through the condyles; it is very important that it should be passed in the anterior part of the condyle; therefore, we have to put it in place under the control of a fluoroscopic screen, as was recommended by Fresson. The reason, therefore, is the following:

The condyles rotate on the tibia; they constitute a half-circle, the axis being transverse approximately through the center of each condyle; we could also compare this to a wheel; when the pin is put through the condyles behind the axis a traction is exerted, the wheel rolls backward and thus increases the displacement backward of the lower fragment. On the contrary, if the pin is passed anterior to the axis the wheel will roll forward and the backward displacement on the lower fragment will be corrected.

We believe that the pin should not be left in place more than six weeks. The vicinity of an infected wound is a constant danger of infection, so much the more serious because it threatens the knee-joint.

The third type is the much comminuted fracture; the bone is completely destroyed for a distance of one or two inches. The exit wound is a large cavity; the débridement in these cases has to be carried out very carefully on account of the danger of gas-bacillus infection. Practically all the bone fragments are detached and have to be removed; there is an important loss of bone substance, that might give a non-union, but this may not occur if a bridge of periosteum is present. The treatment here will be very long, lasting several months. For those cases we use the vertical suspension. This is accomplished by passing a bronze wire through all the tissues of the anterior part of the thigh with a Reverdin or a Moor needle. A finger introduced in the wound catches the wire and fixes it securely around the end of the lower fragment. Traction is made by a weight hanging above the bed of the patient, connected by a cord with the end of the wire.

Shortening of the femur is prevented by traction with a Chutro stirrup or by Tillaux's method.

This suspension can be maintained during months. Some of our fractured femurs were kept for three months with this apparatus in place, and the presence of this wire did not pain them at all nor did it do any harm or cause any complication.

We have also used this method, with excellent results, in cases of

badly united fractures of the lower third, carrying a streptococcic fistula. Here we recommend the subperiosteal resection of the osteitic callus and vertical suspension of the lower fragment. Those cases have done wonderfully.

We may summarize as follows:

1. In oblique fractures with little or no comminution, wiring.

2. In fractures with light comminution, when we expect a beginning of consolidation within the six weeks, ice-tongs or Steinman's pin.

3. In all the cases in which one of the aforesaid methods cannot be used and in which the consolidation is expected to be delayed a very long time, we use the vertical suspension of the lower fragment combined with a horizontal traction on the leg.

PHASES OF WAR SURGERY. BONE TRANSPLANTS FROM THE TIBIA TO THE LOWER JAW FOR LOSS OF SUBSTANCE

By CHARLES A. POWERS, M.D.
DENVER, COLORADO

It is with much hesitation that the writer presents such a small series of cases. His only excuse must lie in the fact that each case was very carefully studied and followed, and, further, that large series are not yet available. In 1916 and 1917 the writer did 11 of these operations at the American Ambulance Hospital of Paris (July, 1917, militarized as the American R. C. Military Hospital No. 1, A. E. F.). An illustrative case is the following:

Case B.—André, B., aged twenty-three years; French, 152d Regiment, Infantry. Wounded in action August 15, 1915, at Sondemarc in Alsace by fragments of high explosive shell. Multiple injuries, including shatter of right portion of lower jaw and compound comminuted fracture of the skull in the frontal region. Ordinary management, patient passing from one French Hospital to another. Hospitalized at Toulouse for one year. Admitted to American Ambulance Hospital of Paris, April 11, 1917, with all wounds healed. (Patient has had no symptoms from skull fracture; brain pulsation is felt.)

There was pseudarthrosis of the right side of the body of the lower jaw, with apparently considerable loss of substance. Heavy dense scar tissue on the right side of the face in this region. Widest possible preliminary removal of this cicatrix.

July 16, 1917. Bone transplant.[1] (On the preceding day dental splints had been applied by the efficient dental department of the hospital and "open-bite" supports applied in the usual way.) The entire region of lost bone was a dense mass of hard cicatricial tissue, despite the preliminary attempt at excision of the scar. This cicatricial tissue was removed as much as possible, great care being taken to avoid opening the oral cavity. Posterior fragment exposed, it being much drawn in by the pterygoid muscles. Very careful dissection of the soft parts from the bone, especially at the end of the fragment, where it was solidly fibrous and densely adherent. Anterior fragment exposed and cleared. Loss of substance was found to be something over two inches. Seat made in posterior fragment by an Albee saw and a chisel, care being taken to go well down into the bleeding bone. Seat made in anterior fragment, but this difficult because of dense eburnation of bone. Cultures (proving negative) were taken from each cut in bone. Dry wound secured. Fragment of suitable length taken from the tibia by a twin saw, the periosteum being so raised laterally as to drop over the sides of the fragment. Ends of graft bevelled so that the periosteum dropped over these obliquely cut ends. Transplant applied to the lower jaw, held in place by forceps, and the soft tissues carefully sewed over it by interrupted sutures of fine black silk. The sutured soft parts held the fragment in place, but the fragment did not "wedge" into the two portions of the lower jaw proper. Covering of transplant difficult in this case because of the density of cicatricial tissue. Subcuticular stitch to skin without drainage. Very large, firm, carefully applied dressing, with heavy crinolin support. Leg put up in plaster of Paris for six weeks. Each subsequent dressing done with the detail of an aseptic operation. Smooth course. Interdental supports and splints removed at the end of three months and solid union found throughout. Patient reëxamined from time to time for one year from date of operation.[2] The union held. Function of jaw prac-

[1] The operation here detailed was the type adopted in all of the cases.

[2] Fig. 5. This is the second case from the left in picture.

tically perfect. (Fig. 1. *X*-ray taken nine months after operation.)

FURTHER CASE. B., aged twenty-two years; wounded September 25, 1915. Had been in several French Hospitals. Entered the American Ambulance Hospital at Neuilly June 13,

FIG. 1.—B-1. Showing transplant nine months after operation.

1917, with double pseudarthrosis. Considerable loss of bone on both the right and the left sides of the lower jaw in front of the angles. Loose middle fragment very freely movable. Operation on left side November 6, 1917, with "open-bite," interdental splint fixation of fragments. No infection. Interdental splint not disturbed and the right side subjected to a similar operation

ten weeks later. Perfectly smooth course. Fixation maintained for six months from date of first operation, when all interdental splints were removed and firm consolidation found on both sides of the jaw. On letting the jaws together at the end of six months, no ankylosis was present on either side. In order to get

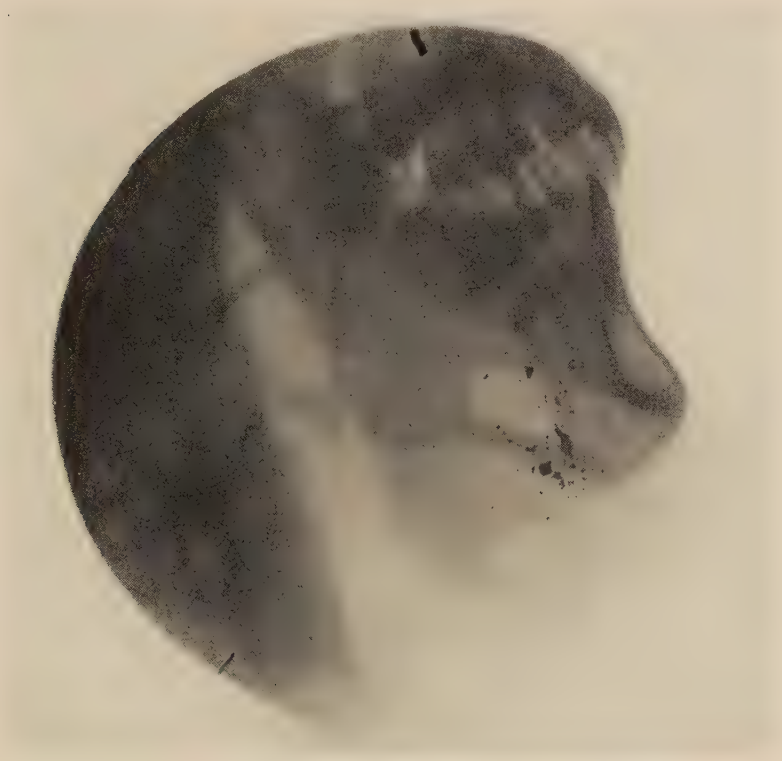


FIG. 2.—B–t. Showing transplant eight months after operation. Black specks represent tiny foreign bodies diffused in soft tissue.

perfect approximation of the dental arcades, it was necessary to extract one posterior right upper molar—a matter of slight surgical importance. This man was kept under observation for eight months after the first operation, or until the American wounded filled the hospital in the summer of 1918. (See Fig. 5, soldier in middle of the picture.)

Results. Eleven transplants made on 10 patients, this last related case being double. In these 11 operations there were three infections, each infected case being followed by loss of the graft. Results in the 11 cases: 7 cases, or 63+ per cent., of complete successes; 3, or 27+ per cent., of complete failures;

Fig. 3.—Bai–t. Showing transplant eight months after operation.

and 1 case, 9 per cent., undetermined, but a probable success when last seen in June, 1918. (The conditions of success embraced absolutely solid consolidation, excellent dental approximation,[1] good mastication of not too hard food, and a good speaking voice.)

[1] Naturally, suitable artificial teeth were put in.

If, however, we divide these 11 cases into two classes, by years, we find 5 operations done in 1916 with 2 complete successes, or 40 per cent., and 3 complete failures, or 60 per cent.; while the 6 operations done in 1917 (added experience) show 5 full successes, 83 per cent., and 1 undetermined result, but probable success, 17 per cent.

REMARKS. The war has brought greatly increased experience in transplants to the lower jaw, yet there is not a unanimity of

FIG. 4.—Transplants of tibia to lower jaw. Viewed from left to right, the first case was a failure, the other two cases were successful.

opinion as to the form of operation, or, indeed, as to the real value of any procedure. Leriche[1] says: "We believe we are justified in concluding that at the present moment the results of bone-grafting in mandibular pseudarthrosis are not demonstrated. As Sébileau has said, they are encouraging, no more." Morestin told the writer that he used cartilage and inserted it chiefly for its esthetic value. Imbert and Réal (1917) agree with Sébileau.

Medical and surgical Therapy, 1918, vol. iv.

FIG. 5.—Transplants of tibia to lower jaw. Viewed from left to right, the first four cases were successful, the fifth case a probable success. The soldier in the middle had transplants to both sides of jaw and at time of taking of picture was still in "open bite." (Photograph taken April 3, 1918.)

Hull, in the second edition of his excellent work,[1] says: "All engaged in this work are unanimous on one point, that it cannot be safely undertaken in less than six months from the date of the injury. As it takes another six months to estimate truly the results the lack of series of published cases is easily understood." In June, 1918, a surgeon from the British center at Sidcup told the writer they were doing some of these cases with the closed bite under rectal anesthesia. They had not at that time formulated an opinion as to the value of any particular operation.

It goes without saying that very much time will be needed to determine the ultimate fate of any bone transplants. Further experience will be required to demonstrate the relative value of different procedures, but the writer is convinced that something should be attempted for the relief of these seriously disabled people.

[1] Surgery in War, 1918.

CRANIOPLASTY: THE VALUE OF A GRAFT OF BONE, CARTILAGE OR FASCIA IN THE CLOSURE OF CRANIAL DEFECTS CAUSED BY WOUNDS IN WAR

A STUDY OF THE RESULTS OBTAINED IN A SERIES OF FORTY-TWO OPERATIONS

By ALEXANDER PRIMROSE, C.M.
TORONTO, CANADA

The degree of disability resulting from the existence of a defect in the bony vault of the cranium varies within wide limits and is dependent upon a number of factors, including the size of the opening, the amount of scar tissue and the damage sustained by the meninges of the brain as well as by the brain substance itself. There is also a certain psychic factor which has to be reckoned with in estimating the disability: the mental attitude of the wounded man may tend to give one an exaggerated conception of his trouble as indicated by the subjective symptoms or, in exceptional circumstances, the reverse may be the case.

The series of cases described in the present paper consists of 42 cranioplasties performed in 38 patients. The treatment was carried out in the military wards of the Toronto General Hospital. The writer was in charge of this special clinic and had as members of his staff Lieut.-Col. Gilmour, Major G. E. Wilson, Major Gaby and Captain Shenstone. Most of the operations were done by these officers.

Age. The youngest patient operated upon was nineteen years of age, the oldest forty years of age; the average being

26.5 years. It will thus be seen that they were young men, most of them healthy and vigorous, capable of withstanding the immediate effects of an extensive operation satisfactorily and possessing excellent reparative power.

Region of Cranium Affected. The portion of the skull in which the gap was located is indicated in the following table:

Frontal	12
Frontoparietal	8
Parietal	13
Occipitoparietal	6
Occipital	2
Temporo-occipital	1
Total	42

The Cause of the Wound. All the patients received their wounds on active service overseas as follows:

Bullet, shrapnel, etc.	36
Aëroplane bomb	1
Shell concussion causing unconsciousness and fracture due to fall	1
Hit by sandbag	1
Hit by aëroplane propeller	2
Pyemic abscess and necrosis	1
Total	42

Time elapsing between the date of receiving wound and the date of the operation of cranioplasty:

1 case	50 months
1 case	46 "
5 cases	22 to 32 "
11 cases	10 to 16 "
20 cases	4 to 9 "

38 cases, average 13.2 months.

The symptoms complained of by individual patients varied in proportion to the extent of his wound and the region of the brain involved in the injury. Thus where the so-called "silent" areas of the brain were involved the symptoms would be subjective in character only, while in others there would be evidence

of an organic lesion, such as hemiplegia, aphasia, defective vision, loss of hearing, loss of smell, etc.

We have made a careful analysis of the symptoms and the results obtained by a successful cranioplasty in the whole series of forty-two operations. This seemed to us the best way of estimating from our experiences the benefit, or otherwise, of undertaking an operation for the closure of the cranial gap. The results are as follows:

SYMPTOMS AND RESULTS OF OPERATION

Headache. Nearly all cases suffered from headache. There were four exceptions.

CASE I.—A man, aged twenty-nine years, wounded in the left parietal region in August, 1918, followed by complete hemiplegia (motor and sensory) showed steady improvement after the removal of a F. B. eleven days after the wound was received. He suffered no disability on coming to our clinic save a sense of insecurity: he had no headache and no dizziness; he wished an operation for cosmetic purposes and for safety. A bone graft was done on February 2, 1919, six months after receiving the wound, with excellent results.

CASE II.—A man, aged twenty-six years, with a hiatus 2.5 cm. by 2 cm. in left temporo-occipital region. He had no headache and no dizziness but felt nervous and afraid. He was also subject to occasional fits of unconsciousness when excited or fatigued. There had been right hemiplegia immediately after the wound was received. Some weakness of right arm and leg still remain. A cartilage graft was inserted January 15, 1919, one year after receiving the wound. The result has been entirely satisfactory and he no longer suffers from fits of unconsciousness.

CASE III.—A man, aged twenty-four years, with right parietal gap in the skull. A F.B. had perforated his steel helmet and struck a glancing blow on the skull. He became partially hemiplegic following the wound, which was received August

27, 1918. At the time the cranioplasty was performed, January 23, 1919, five months after receiving wound, he had no headache but had some dizziness. A bone graft was inserted and he recovered; he lost his dizziness and secured a sense of safety and security which he lacked before operation.

Case IV.—A man, aged twenty years, received a wound (October 20, 1917) in left parieto-occipital region. He suffered no headache. He had obviously had some degree of hemiplegia after receiving the wound and on admission to our clinic had weakness of the right hand and leg. A gap 7 by 4 cm. was closed by cartilage graft (May 29, 1918). Subsequent to the operation he had a certain amount of headache. The hiatus remained successfully closed. It is worthy of note that all cases free from headache were wounds in the parietal region involving the Rolandic area and suffering hemiplegia.

Results of Operation on Headache. As a rule, headache was completely relieved by a successful cranioplasty. The exceptions were as follows:

Case I.—A man, aged twenty-four years, with a double cranial defect had his first operation for closure of a frontal lesion six months after the wound, and a second operation for closure of an occipital defect two months subsequently. These were successful cartilage grafts. The headaches were only slightly relieved.

Case II.—A man, aged twenty years, with a left parietal lesion had a successful cartilage graft seven months after the wound. The headache was greatly relieved but not entirely.

Case III.—A man, aged thirty years, with a large right frontoparietal lesion had a cartilage graft twenty-four months after wound. The headache persisted.

Case IV.—A man, aged twenty-two years, with a right frontal lesion had a cartilage graft seven months after wound. His headache was, if anything, worse than before.

Case V.—A man, aged twenty-nine years, with a left parietal defect had cartilage graft ten months after wound. The headaches were relieved but not entirely abolished.

Case VI.—A man, aged twenty-three years, with a right parietal defect had cartilage graft twenty-two months after wound. There was no improvement in headaches.

Case VII.—A man, aged thirty-three years, with right parietal defect had bone graft four months after wound. The headaches persisted as before.

Case VIII.—A man, aged twenty-seven years, with parieto-occipital defect had bone graft seven months after wound. The headaches continued.

Case IX.—A man, aged twenty years, with parieto-occipital defect had cartilage graft seven months after wound. The headache was largely relieved but not wholly.

Case X.—A man, aged thirty-one years, with right parietal defect had cartilage graft twenty-two months after wound. His headaches and dizziness were not relieved.

The question of relief or otherwise from headache was not dependent upon the length of time which elapsed from the time of the wound until the defect was closed. Thus a man suffering constant headache was relieved by a cranioplasty after a lapse of fifty months, while in another case there was no relief of headache after a lapse of four months.

Dizziness. In most instances if a man had no headache he had no dizziness, but, as a fact, in the whole series of 42 cases there were only 4 cases free from either headache or dizziness. The dizziness was a very distressing symptom. The conditions under which it developed varied:

Thus one man, aged twenty-two years, with a left parietal gap, got dizzy when he went to bed and suffered a very disagreeable sensation as if the bed were upsetting. Another man, aged twenty-three, with a frontal gap 5 cm. by 3.5 cm. would occasionally fall from dizziness but would not lose consciousness. Another man, aged thirty-three years, with a posterior parietal gap (4 cm. by 4 cm.) felt dizzy when lying down. On the other hand, a man, aged thirty-two years, with a left frontal gap (2.5 cm. by 5 cm.) was compelled to lie down for relief when he got dizzy. Another man, aged twenty years, with a parietal

gap (5 cm. by 5 cm.) would sometimes fall because of dizziness. This man had worn rubber heels in order to prevent jarring and by this means obtained considerable relief from his headache and giddiness.

The headache and dizziness would be aggravated by exertion or fatigue, and would often be induced by turning the head rapidly.

Results of Operation on Dizziness. The relief of dizziness by operation was more pronounced than that of headache. The exceptions were few.

CASE I.—A man, aged twenty-four years, with a double lesion, one in the parietal and one in the occipital region, had a bone graft in the parietal gap five months after the wound and a cartilage graft in the occipital gap four months subsequently. The attacks of dizziness were much less frequent, but they were not entirely relieved.

CASE II.—A man, aged thirty-one years, with a right parietal lesion had a cartilage graft twenty-two months after wound. His dizziness and headache were not relieved.

Loss of Memory. This was recorded in seven specific instances, but there were doubtless others where the history is incomplete. It was markedly the case that the loss of memory was for recent events, while incidents of older date were comparatively readily recalled. The regions involved were as follows: (1) Fronto-parietal; (2) left parieto-occipital; (3) double—left parietal and left occipital; (4) left parietal; (5) frontal; (6) right frontal; (7) parieto-occipital.

Results of Operation. The effect of operation was naturally not immediately apparent, but in some instances it was noted after a lapse of some weeks or months the memory was much improved.

Deafness. Deafness was recorded in four instances. These were gaps recorded as follows: (1) Left frontoparietal; (2) left parietal; (3) left temporo-occipital; (4) left parietal.

The results of operation were not appreciable.

Noises in the Ear. There were 2 cases, one a gap in fronto-parietal and the other in a similar locality.

The result of operation was not appreciable.

Defective Vision. There were 6 cases in which vision was affected.

Case I.—A man, aged twenty-four years, with a double lesion, one gap (5 cm. by 3 cm.) in the frontal, and another gap (3 cm. by 3 cm.) in the occipito-parietal region, complained that vision was blurred.

Case II.—A man, aged twenty-four years, with double lesion, one gap in the left parietal and one in the left occipital region, had homonymous hemianopsia with 75 per cent. disability.

Case III.—A man, aged thirty-two years, with a left parietal lesion complained of "poor vision."

Case IV.—A man, aged twenty-two years, with right frontal lesion complained of vision becoming blurred.

Case V.—A man, aged thirty-three years, with a parieto-occipital lesion had right-sided homonymous hemianopsia.

Case VI.—A man, aged twenty-five years, with left frontal lesion suffered from "eye strain."

The Results of Operation. No improvement was apparent in any of these cases.

Aphasia.—There were 5 cases in which aphasia was noted in varying degree:

Case I.—A man, aged twenty-six years, with a left fronto-parietal lesion had difficulty in speech and was at first unable to read; he gradually regained the power of reading.

Case II.—A man, aged twenty-six years, with a left anterior parietal lesion had difficulty in speaking.

Case III.—A man, aged twenty-two years, with a right frontal lesion could speak and read as well as formerly, but had some difficulty in recalling names.

Case IV.—A man, aged twenty-two years, with a left parietal lesion had difficulty in putting thoughts into words.

Case V.—A man, aged thirty-three, with a parieto-occipital lesion had lost at first the power of speech. This gradually

improved, but his speech was still slow twenty-nine months after the reception of wound.

Results of Operation. There were no observations to suggest that the operative procedure had any effect upon the aphasic condition. Many of these cases showed a slow process of recovery before the operation was undertaken and this continued subsequent thereto.

Hemiplegia. There were 15 cases of hemiplegia in varying degrees. Unfortunately, no accurate clinical record is available of the precise extent or degree of the hemiplegia which supervened after receiving the wound. Our patients on admission to our clinic exhibited such symptoms as exaggerated reflexes, spastic gait, anesthesiæ, Babinski's sign and certain contractures.

Case I.—A man, aged twenty years, with a left parieto-occipital lesion had weakness of the right hand and leg, which was observed for two months after receiving wound: this had almost entirely cleared up when he came to our clinic seven months after the wound.

Case II.—A man, aged twenty-four years, with double lesion, left parietal and left occipital, had immediate weakness of the right arm and leg; this continued when examined nine months after the wound.

Case III.—A man, aged twenty-six years, with a left parietal lesion had right hemiplegia which cleared up, but weakness still continued thirteen months after the wound.

Case IV.—A man, aged thirty years, with a left occipital lesion had the right leg partially paralyzed.

Case V.—A man, aged twenty-six years, with a left temporo-occipital lesion was trephined the day after being wounded. He was paralyzed in the right arm and the right leg. When coming to our clinic twelve months after being wounded he walked with a limp and had weakness of the right leg. There was also marked weakness of the right hand. Two months after repair of the cranial gap the record states that there was marked improvement in function in the leg and hand.

Case VI.—A man, aged twenty-six years, with a left fronto-parietal lesion had a fit immediately after the injury and was paralyzed in the left side. He was unconscious for three weeks, a fortnight later the paralysis cleared up on the left side and the right side became paralyzed. This subsequently cleared up almost entirely, but after a cartilage graft fifteen months subsequent to the wound right hemiplegia again developed and he was readmitted after a lapse of six months, suffering also from severe Jacksonian epilepsy. The graft was removed and a fascial graft substituted after free dissection of the scar tissue. The paralysis completely cleared in ten days and the fits ceased to recur.

Case VII.—A man, aged thirty-one years, with a right parietal lesion had complete left hemiplegia which cleared up largely, so that twenty-two months after the wound a weakness of the left arm and leg is alone recorded.

Case VIII.—A man, aged twenty-four years, with a right parietal lesion was partially paralyzed on the left side and lost complete control of the left hand; this had completely cleared up when examined five months after the wound.

Case IX.—A man, aged twenty-nine years, with a left parietal lesion had a F. B. removed in the C. C. S. and is recorded as having the entire left side paralyzed. He developed Jacksonian epilepsy while the hemiplegia largely cleared up. Such was his condition when he entered our clinic ten months after receiving wound.

Case X.—A man, aged thirty-three years, with a right parietal lesion was paralyzed in the left arm and leg for a month. There was still weakness in the arm and leg when examined four months after wound.

Case XI.—A man, aged thirty-five years, with left parietal lesion had hemiplegia and twenty-eight months after the wound he walks with a spastic gait.

Case XII.—A man, aged twenty years, with a left parieto-occipital lesion had weakness of the hand and leg for two months after the wound, when it cleared up.

CASE XIII.—A man, aged twenty-seven, with a right fronto-parietal lesion had weakness of the left arm and leg when examined eighteen months after the wound.

CASE XIV.—A man, aged thirty-three years, with a left perieto-occipital lesion of a most extensive character (gap 9 cm. by 12 cm.) had immediate right hemiplegia which gradually improved. When examined thirty-two months after the wound there remained only a weakness and slight numbness of the left foot.

CASE XV.—A man, aged thirty-five years, with a right occipital lesion had a left hemiplegia which gradually improved. When examined thirty-two months after the wound there remained only a weakness and slight numbness of the left foot.

Lesions Producing Hemiplegia. Parietal, 7; parieto-occipital, 3; frontoparietal, 2; temporo-occipital, 1; occipital, 2; total, 15.

Results of Operation. It is difficult to secure sufficient data in detail from the previous records of these men to make a comparative study as valuable as otherwise would have been the case. Nevertheless, some instructive observations were made, although in the most general terms, and with a most meagre history of the progress of certain of these cases.

It would appear that the hemiplegia was more or less complete in many instances and developed either immediately on receipt of the wound or, what was more commonly the case, within the first few hours afterward. In every instance the condition showed progressive improvement, usually leaving a residual weakness, but in exceptional cases clearing up entirely.

It cannot be said that the closure of the defect had any remedial effect upon paralysis in these cases. In one instance hemiplegia developed after a cartilage graft had been inserted, along with Jacksonian seizures. The paralysis entirely cleared up and the fits ceased to recur after removal of the graft, free dissection of scar tissue and the insertion of a fascial graft.

Jacksonian Epilepsy. There were 7 cases in whom epilepsy developed. Six of these were of the Jacksonian type.

Case I.—A man, aged twenty-four years, with a double lesion, one in the right frontal region and one in the occipitoparietal region. He was admitted to the clinic six months after the wound and had two fits in the ward before operation. The day after the operation for closure of a gap he had a fit, but they did not recur.

Case II.—A man, aged twenty-six years, with a left frontoparietal lesion had a fit immediately after being wounded. On admission fifteen months after the wound he was having frequent fits, as many as three a day. After operation he had three fits during the first night. During the subsequent fifty-four days while in hospital he only had one fit. These, however, subsequently recurred and after a period of four months he was readmitted; the cartilage graft was removed and a fascial graft substituted after free dissection of scar tissue, including dura mater and cortex. At the time of his readmission he had right hemiplegia. After the last operation this completely cleared in ten days and no more fits developed up to time of discharge, nineteen days subsequently.

Case III.—A man, aged twenty-nine years, with a left parietal lesion, wounded November, 1917. A F. B. was removed in the C. C. S.; paralysis of the entire left side followed. This cleared up and the first fit occurred three months afterward. Fits recurred about once a month. There was an aura of choking and nausea. When fit develops it begins on the right side, clonic in type, he becomes unconscious and cyanosed, sleeps for two hours and awakens with terrific headache. Cranioplasty September 25, 1918, and reported no return of Jacksonian epilepsy in five months (February, 1919).

Case IV.—A man, aged twenty-six years, with a left parietal lesion, wounded August 15, 1917, followed by right hemiplegia at the C. C. S. Bits of bone and brain matter were removed. Seventeen days afterward parts of a hernia cerebri were removed, and four days subsequently the entire hernia cerebri was removed. He had aphasia, blurred vision, dizziness and frontal headache. The fits were Jacksonian in type,

beginning by clonic spasms of right foot. Cranioplasty, September 23, 1918 (cartilage), was performed. The wound suppurated and the cartilage sloughed out. Transferred to C. M. C. H. November 27, 1918. One fit had developed the day after operation. He had respite from these seizures for a time, but they eventually recurred and he died in a convulsion four months after the operation.

Case V.—A man, aged twenty-six years, with left temporo-occipital lesion. He was trephined the day after being wounded. He was paralyzed in the right arm and right leg. There is no history of convulsions following, but he suffered from occasional attacks of unconsciousness when excited or fatigued—*petit mal;* a cranioplasty was done January 15, 1919; one attack occurred the day after the operation but none subsequently.

Case VI.—A man, aged thirty-three years, with a very extensive gap in parieto-occipital region. Right hemiplegia followed the wound and subsequently he developed fits which recurred at the rate of about one every three months. A bone graft from the cadaver was introduced twenty-nine months after the wound. He had a fit three days afterward and a second seizure three and a half months subsequently.

Case VII.—A man, aged twenty-seven years, with a right frontoparietal lesion was paralyzed in the left side. This largely cleared and he had a bone graft inserted about a year after receiving wound, in Washington. Subsequently he developed Jacksonian epilepsy, with recurrence of the paralysis, and two years after the wound the bone graft was removed, a free dissection of scar tissue made, and a fascial graft substituted. He made an excellent recovery; the paralysis entirely disappeared and thus far (four months after operation) the fits have not recurred.

Lesions Associated with the Development of Epilepsy. Frontoparietal, 2; frontal and occipitoparietal, 1; parietal, 2; parieto-occipital, 1; temporo-occipital, 1; total, 7.

Results of Operation.—It is worthy of note that of the cases in whom Jacksonian epilepsy developed all had a history of

hemiplegia with one exception, and in all the gap existed in the parietal region of the cranium.

It is hazardous to draw any conclusions as to the effect of closure of a cranial gap upon the course of epilepsy. Undoubtedly relief is in many instances attained, but one cannot say that a permanent cure is effected. In civil practice one has seen acute epilepsy of the Jacksonian type clear up entirely after operation for cerebral abscess, and the patient continue free from seizures for years (in 1 case followed for nine years) with apparently a permanent cure. On the other hand, in my records I have the history of a man who developed his first attack twenty years after a brain injury. It is, therefore, impossible to say that we have effected a cure when, after a cranioplasty, our patients, as in some instances, have remained free from attacks for a few months.

Loss of Sense of Smell. A man, aged twenty-four years, had a double frontal lesion. The bullet entered just above the supra-orbital ridge on one side and made its exit above the supra-orbital ridge on the opposite side. There were two gaps with a bridge of bone between. This man had complete loss of smell, due, no doubt, to injury of the olfactory lobe of the brain.

Result of Operation. The operation had no appreciable effect in restoring function.

Dyspnea. One case is recorded as having difficulty in breathing: this was a man, aged twenty-six years, with a left fronto-parietal lesion who had left hemiplegia and early developed Jacksonian epilepsy. The fits continued and were a feature of his case fifteen months after reception of the wound.

Sense of Fear: Nervous and Afraid of Being Struck on Head: a Feeling of Insecurity. Such sensations were very common in men who had a gap in the cranium. Illustrated by the following:

Case I.—A man, aged twenty-six years, with a gap (3 cm. by 2 cm.) felt nervous and afraid. These sensations disappeared after cranioplasty.

CASE II.—A man, aged twenty-one years, with a left posterior parietal lesion had constant fear of being struck on the head. This was relieved by cranioplasty.

CASE III.—A man, aged twenty-two years, with a right frontal lesion was unable to stand any noise without getting extremely nervous.

Result of Operation. Closure of the gap in such cases is most effective in allaying such distressing symptoms.

Marked Mental Depression. This was recorded in certain instances. A man, aged twenty-three years, with frontal lesion and gap (5 cm. by 3 cm.) who was a great sufferer from headaches and dizziness showed marked mental depression.

Result of Operation. The result of operation is most beneficial.

Features of the Gap: Size, Pulsation, Impulse on Coughing, Depression Below Surrounding Surface. The size varied from a small opening 3 cm. in diameter to a very large hole, which in one case measured 12 cm. long and 9 cm. wide. Most of the cases showed pulsation, but where the gap was small and the scar tissue over it firm, pulsation was absent. In nearly all cases there was an impulse on coughing. A very characteristic feature of these cases which was observed in practically all instances was that the soft tissues covering the hole would bulge when the man stooped over with his head between his knees; on assuming the erect attitude the bulging would be replaced by a marked depression. Lying on the operating table with the head slightly elevated and while under the anesthetic there would be a slight depression as a rule. In one instance there was a marked depression at operation. This was due to the very large size of the gap and to the loss of substance in the meninges and in the brain itself.

Results of Operation. These unfortunate patients all experienced the the greatest possible relief as the result of firm closure of the gap.

The Scar. The character of the scar tissue varied within wide limits. It became most important to study the degree of scar development and its relation to the gap. One feature common

to all was the dense adhesion of the scar to the dura mater, necessitating the most careful dissection of the one from the other. An attempt was made to remove the scar tissue as completely as possible. If this were not done, it would probably slough subsequently, as its vascularity is so poor. Removal of the scar tissue is considered by us a most important feature of our technic.

Nausea and Vomiting. It is a fact worth recording that in not a single instance was vomiting recorded as a symptom. This symptom is common in pathological lesions within the cranium, such as tumors, inflammatory conditions, etc., where increased pressure effects are a feature of the case. It is therefore perhaps not surprising that in the cases under consideration, where the intracranial pressure is, if anything, diminished, vomiting does not occur.

In one case there was nausea; this was present in a man, aged thirty-two years, who was knocked over by a shell exploding near him, sustaining a fracture of the skull in the left parietal region as the result of his fall. Four months after the injury nausea is noted as a feature of his case with headache and dizziness. Cranioplasty was performed, and all his symptoms were relieved.

Restricted Movement of the Lower Jaw. A man, aged twenty-eight years, with a right frontoparietal lesion situated immediately above the zygoma, the scar tissue was firmly incorporated with the temporal muscle, resulting in a fixation of the jaw so that the movement at the temporo-maxillary joint was restricted and he was unable to open his mouth except to a very limited extent. The muscle was freed at an operation performed in our clinic two years after receiving the wound, as a result the jaw movement was increased by 10 per cent.

Result of Operation. The result of operation here, by the removal of scar tissue, was effective in restoring function to a considerable degree.

Type of Graft. Cartilage, 27 cases; bone, 13 cases; fascia, 2 cases; total, 42 cases.

The cartilage grafts were all autogenous: the cartilage was removed from the lower costal cartilages of the patient.

The bone grafts were also autogenous with one exception, and were removed from the tibia of the patient. The exception was that of a large cranial defect which was closed by a piece of parietal bone removed from the human cadaver.

The fascia used was the fascia lata from the thigh of the patient.

There were 3 cases in which a silver plate had been inserted in England to close the gap. In each instance the plate had to be removed. These were as follows:

Case I.—A man, aged twenty-two years, wounded in November, 1917, in frontoparietal region had a silver plate inserted to close the gap. The wound became infected and the plate was removed six months after its insertion. After another lapse of six months, the wound being soundly healed, the writer made a successful cartilage graft relieving the man of his headache and dizziness.

Case II.—A man, aged thirty years, wounded in November, 1914, in the occipital region had a silver plate inserted in England four months later. The history states that following a fit of unconsciousness he had the plate removed in June, 1915. There was evidently some infection as a sinus persisted when admitted to our clinic. In spite of this, however, Major Wilson succeeded in doing a successful cartilage graft in January, 1919.

Case III.—A man, aged twenty-two years, was wounded in October, 1917, in the frontal region. A month afterward he had a silver plate inserted. The wound became infected and the plate was removed six months later. The wound then healed. In October, 1918, Captain Shenstone performed a successful cartilage graft followed by complete relief of his headache and dizziness.

In one instance a bone graft which had been inserted in Washington was removed in our clinic.

The case is as follows:

A man, aged twenty-seven years, was wounded in 1917 and

had two operations in France at both of which fragments of bone were removed. Later a bone graft was done in Washington. He came to us because of having developed severe convulsive seizures and an incomplete hemiplegia with weakness of the leg and arm. In January, 1919, Major Wilson removed the bone graft, and made a free dissection of the scar tissue along with a considerable piece of dura mater. He replaced this by a fascial graft and its adherent fat. The fat was turned toward the brain cortex. The wound healed and the paralysis completely disappeared; thus far the convulsions have not recurred.

The Technic of the Operation. The method of operating in this clinic has recently been described by one of our staff, Major Wilson, in the *Annals of Surgery* for March, 1919. The principles involved and the objects aimed at may be summarized as follows:

In exposing the gap in the cranium, the flap of scalp which is turned down must be freed as far as possible from all scar tissue. This is essential for two reasons, first to get rid of all tissue which may harbor infection, and secondly to provide a covering for our graft which has a good blood supply. The flap does not include the pericranium which is left for the moment undisturbed. The area of skull uncovered must leave a margin of at least 3 cm. surrounding the gap. The reflection of the flap is not easy immediately over the gap, because at this point one usually encounters scar tissue, and it is firmly adherent to the dura mater, which is also scarred. In dissecting the flap free from the dura the latter is often opened at points from which cerebrospinal fluid escapes. Occasionally a fine catgut stitch is necessary to close these small wounds of the dura. In some instances it has been necessary to sacrifice a considerable piece of the dura mater. Under such circumstances we have found it quite satisfactory to transfer a piece of fascia lata from the thigh. The patch of fascia is placed with its fatty side toward the brain cortex, and with its margins underlying the edges of the dural gap. It is then secured in place by a few fine catgut

sutures. The pericranium is now cut by a vertical incision which encircles the gap in the bone. This cut is made 0.5 cm. from the bony margin of the gap. The ribbon of pericranium thus mapped out is raised from the bone by an elevator and turned in upon the dura mater. One continues the separation in the same plane and separates the dura from the under aspect of the bone. By this means the bony margin of the gap is entirely bared on both surfaces. If any rough irregularities of bone project from the margin these are removed by rongeur forceps. The pericranium surrounding the field of operation is also separated from the bone by an elevator to the depth of 1 cm. The object of this is to utilize the cut margin of the pericranium for the purpose of securing the graft, when in place, by suture. By means of a burr or gouge the bony margin is now bevelled off, removing the outer table and leaving the inner table to act as a shelf to receive and support the graft. The bed is now prepared for the reception of the graft. Throughout the operation most careful attention is paid to hemostasis. If it is proposed to make a cartilage graft, then a vertical incision six inches long is made two inches to the right of the middle line over the lower costal margin. The incision is carried down through the rectus muscle, which is retracted, and the cartilages bared. One then removes two-thirds of the outer surface of the cartilage, shaping a graft of sufficient size to fit the gap in the cranium. The piece of cartilage is subsequently fashioned to the exact shape and size necessary by cutting it with a sharp knife upon a wooden block. It is now placed in position, the edges of the graft resting firmly upon the ledge of the inner table, which has been prepared for its reception. Fine catgut sutures are now passed through the cartilage and the loose margin of pericranium which immediately surrounds it. The flap of scalp is then replaced over the graft and accurately secured by the silkworm-gut suture. A small drain is inserted at a suitable point to prevent the formation of a hematoma. This drain is retained in position for twenty-four hours.

The Cartilage Graft. In placing the cartilage graft one or two additional precautions are necessary. The cartilage must be laid with the perichondrium toward the dura. In fact, it will be found difficult to place it otherwise, as it naturally curls somewhat to form a slightly concave surface on the side of the perichondrium, thus fitting more readily the contour of the skull. We have learned by experience that it is absolutely necessary to make the graft completely bridge the gap and lie supported upon the ledge of inner table prepared for its reception. If, for example, two pieces of cartilage are used to span the gap and their ends meet and lie free in the center of the gap, the result is a failure to secure firmness, a certain amount of yielding will occur in such a graft which will permit of impulse on coughing and possibly pulsation. On the other hand, if the gap is unusually large, it may be necessary to use several pieces of cartilage to fill it. A good firm result may be obtained under such circumstances, provided each piece of cartilage completely spans the gap and rests securely at either end upon the ledge of inner table.

The Bone Graft. The bone graft in all our cases, with one exception, has been cut from the tibia by means of a saw. Before doing this, however, the periosteum is cut through over an area of somewhat larger pattern and turned in over the graft while the saw cut is being made. The graft is now raised from the tibia by means of a chisel. The graft is placed in position in the cranial gap and is fitted in similar fashion to that described for the cartilage graft. The redundant periosteum is now sutured to the surrounding pericranium and the graft is thus securely retained in place. In some instances we have drilled the graft and similarly drilled holes in the ledge of inner table and secured the graft by passing catgut through these holes, but this is not necessary.

The Bone Button Graft. One of our staff, Major Gaby, has devised a method of making bone grafts, which, in suitable cases, answers admirably. The gap in the cranium is exposed in the manner already described. A trephine is then applied

over the gap and the outer table cut through. The outer table within the circle of the trephine cut is then chiselled off and the inner table left as the shelf for the reception of the graft. The same trephine is now used to cut a graft from the tibia, cutting the periosteum over an area embraced by a larger circle and turning it in over the graft before the trephine is applied. A button of bone of suitable size is now isolated by the trephine and separated from the bone by means of a fine chisel. This is now placed in position in the cranial gap and secured there by stitching the periosteum to the pericranium with catgut. The method answers admirably, provided the gap to be closed is more or less circular in shape and not too large. Major Gaby has succeeded in closing the gap requiring a trephine two inches in diameter, by this means utilizing the entire width of the inner surface of the tibia. The tibial surface is not quite wide enough for the two-inch trephine, but the small part of the graft at opposite sides which fails to reach the supporting ledge in the cranial gap does not materially interfere with the firmness of the result. In small gaps the button fits accurately and is supported around its entire circumference.

The same principle may be applied in certain cases where the long diameter of the defect is too great for the use of a trephine. A rectangular ledge is cut by an Albee motor saw with a guide which prevents the saw cutting to a greater depth than the diploë. The outer table is then chiselled off, as in the trephine method. A tibial graft of accurate size is then cut with the motor saw, cutting to the same depth. The graft is then freed from the tibia by a very thin osteotome. This graft is then fitted in place in the same way as the bone button.

The Bone Graft from the Cadaver. This means of closing a gap was utilized in one of our cases. It is one of unusual interest because of the very large size of the gap accompanied by a considerable loss of cranial contents. The method adopted will best be understood by detailing the case *in extenso.* It is as follows:

A man, aged thirty-three years, with a parieto-occipital

lesion, the result of a wound received in September, 1916, was operated upon in our clinic twenty-nine months afterward. He had hemiplegia after the wound and developed Jacksonian epilepsy. On admission he walked with a spastic gait, had flexure of the hand with plantar flexion of the foot and right

FIG. 1.—Gap 9 cm. by 12 cm. closed by bone from a cadaver. *X*-ray before operation.

homonymous hemianopsia. His fits recurred at intervals of about three months. He had a very large cranial defect.

A piece of the parietal bone of a cadaver was prepared for the purpose of the graft. The exact measurements were 12 cm. by 9 cm. The intention was to close the gap in the cranium

of our patient by placing the graft in the hiatus after preparing it in a special manner to ensure its vascularization and its firm consolidation with the tissues. The study of the fate of the graft in cases where it has been used in the plastic surgery of bone has led to considerable discussion as to the preservation

FIG. 2.—Gap 9 cm. by 12 cm. with bone from cadaver as a graft. *X*-ray seven days after operation.

of vitality in the case of the transference of the graft direct from living bone. Whatever interpretation may be placed upon the histological findings in experimental work there is no room for doubt as to the nature of these findings. Gallie and Robertson have shown that in the transplantation of grafts in the long

bones of dogs there is a certain definite histological picture observed, while studying the changes which take place in the graft at various intervals until complete union of a fracture has occurred and firm consolidation of the graft with the living bone of the recipient dog has been secured. There is no differ-

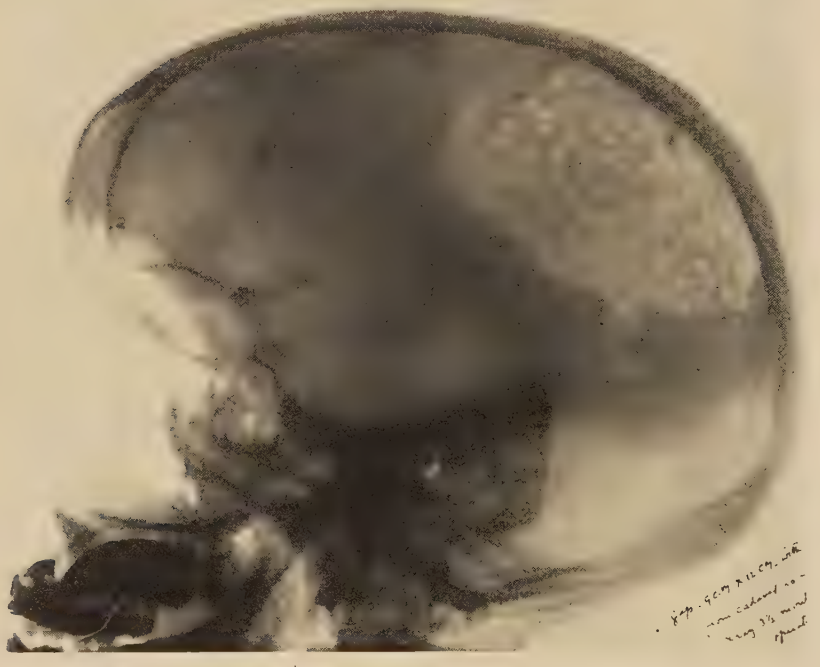


FIG. 3.—Gap 9 cm. by 12 cm. with bone from cadaver as a graft. *X*-ray three and one-half months after operation.

ence in their findings between dead (boiled) bone and bone which has been immediately transferred from living bone for the purpose of the graft. The main features are vascularization of the graft by the ingrowth of new bloodvessels and the deposition of cells (osteoblasts) leading eventually to firm union. It would seem, therefore, that the graft should be prepared in

such fashion as to favor this vascularization as much as possible. Hence it is found that cancellous bone is more suitable for the purpose than compact bone. The more porous the graft the more readily the bloodvessels grow into it. The sclerosed bone in the neighborhood of most ununited fractures is most unsuitable for such vascularization.

With these objects in view, it was determined to prepare the large graft of parietal bone so as to favor its vascularization as much as possible. The inner table of the piece of parietal bone removed from the cadaver was reamed off, leaving the rough cancellous surface of the diploë exposed. The bone was then penetrated by numerous holes through its entire thickness, these holes were 3 mm. in diameter and were placed with intervals of about 6 mm. over the entire graft, thus converting it into a sieve while still preserving a firm structure of sufficient stability for our purpose. The graft was then boiled and was preserved aseptic. At the operation the scalp of the patient was turned down in a flap, after a curved incision, so as to expose the hiatus in the skull, separating by dissection the scalp from the underlying adherent dura mater. This dissection was rendered difficult by the scar tissue present and some holes were made in the dura, allowing escape of cerebrospinal fluid during the process. Eventually the dissection was successfully accomplished and the margins of the hiatus were clearly defined. The pericranium was put 1 cm. from the edge of the hiatus and was divided from the bone and turned in upon the dura mater, the latter was separated for 1 cm. from the under aspect of the bone edge all around the hiatus, so that one had the entire irregular edge of the bone surrounding the gap completely bare. The outer table of this bony ledge was reamed off; the margins of the graft had previously been bevelled in similar fashion, but on its inner surface; the graft was cut so that it fitted the hiatus accurately. The ledge formed of the inner table of the patient's skull was drilled with a number of holes and the graft was firmly secured in place by catgut passed through these holes and through the adjacent holes in the graft.

When we placed the graft in position over the hiatus it became evident that through loss of brain substance there was a considerable depression so that a considerable space existed between the graft and the dura mater underlying it. It was recognized that this would be a distinct menace, as it would certainly fill with blood or serum which would favor suppuration. We therefore filled in this cavity by removing a flap of fascia lata from the man's thigh. Fortunately he was fairly stout and we took a good thick pad of superficial fat along with the fascia lata. The plug of fat was turned toward the dura and the flap of fascia secured in place by a few catgut stitches, thus successfully filling the space beneath our bone graft. The scalp wound was then brought over the graft and secured by interrupted silkworm-gut sutures.

The man made an excellent recovery. It is now four months since the operation. He had a fit three days after the operation and a second seizure after the lapse of three months and a half. He is infinitely more comfortable than before the operation; he can now walk without assistance, a thing impossible for him hitherto. He has lost the headache which formerly distressed him; the mental depression from which he formerly suffered has entirely disappeared. The *x*-ray picture four months after the graft was inserted shows marked changes with gradual disappearance of the holes in certain portions of the graft, with apparently some condensation of the bone at these points.

The Fascial Graft. The value of this form of graft is apparent in certain cases. In particular where there is much scar tissue and a graft of bone or cartilage is not successful. The operation consists in making a very free dissection of the scar tissue, including the implicated portion of the dura and cutting well down upon the cerebral cortex. This usually means, in such cases, the removal of a piece of dura almost as large as the cranial defect. A suitable piece of fascia lata is now obtained along with some of the overlying fat. The patch of fascia is somewhat larger than the defect in the dura. It is placed in

position with the fatty surface toward the brain. The edges of the graft are made to underlie the edges of the dura and are secured there by fine catgut sutures. The scalp flap is then brought over the graft and sutured in position. Major Wilson of our clinic carried out this procedure in 2 cases with excellent results. In 1 case a man, aged twenty-six years, had an aggravation of epileptiform seizures after a cartilage graft and became hemiplegic. The cartilage graft was removed after the lapse of a month and the fascial graft substituted. The paralysis promptly cleared up and the fits ceased to recur. The case is too recent to conclude that he has permanent immunity from fits. The other case was a man, aged twenty-seven years, wounded in 1917 in the frontoparietal region. A bone graft was subsequently introduced, and after a lapse of some months he was admitted to our clinic suffering from severe convulsions requiring an anesthetic to control them, and with left hemiplegia. The bone graft was removed and a fascial graft introduced. The paralysis subsequently disappeared and he had no recurrence of fits when last heard from three months after operation.

Mortality. There was no mortality in the series of 42 operations. Some of the patients in whom extensive operations were performed suffered severely from shock, but they all recovered. One of our patients (No. 4 in the series of cases of Jacksonian epilepsy) left the clinic, but subsequently continued to have convulsions of a most aggravated type. He eventually died in a convulsion four months after his operation. He had been subject to these seizures for six months prior to the performance of the cranioplasty, consequently his death could not be ascribed to the operation.

Infection. It is remarkable that infection does not occur more frequently in view of the amount of scar tissue present and the fact that the vast majority of these patients must have had infected wounds primarily. In two of our cases a granular material, resembling bone dust, was found at the margins of the gap in the cranium. A culture of staphylococcus was obtained from both of these. In spite of that fact both wounds

healed without suppuration and a firm successful closure was secured. It is obvious that the resistance of the tissues of the scalp and cranium to infection is much greater than the tissues about an infected bone in the extremities, where, notoriously, plastic work invariably fails in the presence of infection.

Infection of the wound followed in 5 of our cases only. In 2 of these cases (which were cartilage grafts) in spite of the infection, the wound healed and the graft remained firm. In 3 of the cases the graft was either removed or sloughed out. Two of these were cartilage and one was a bone graft.

Causes of Failure of the Graft. I refer here merely to the failure to secure a firm closure of the gap by our operation. There were five of these. Three of them were the 3 cases of infection referred to in the preceding paragraph where the graft came away. The other two were among our first cases in which we failed to make the cartilage completely span the gap and lie, as it should have done, with each extremity supported on the ledge of inner table prepared for it. In one of these we removed the first graft and performed a second operation which was completely successful. The other showed some pulsation and impulse on coughing, but it was so slight we did not interfere. His symptoms were improved, but he still suffered from some slight headache.

The Fate of the Graft. Our cases are all too recent to make any final statement regarding this most important phase of the subject under discussion. We have, however, made one or two observations of interest. Thus, in removing the cartilage in the case of insecure graft referred to above, one found it firmly united to the tissues in which it was imbedded, including the margins of the gap. Our pathologist, Capt. Laughlin, reports the histological findings as follows:

The section embraces a portion of cartilage and subjacent fibrous tissue stroma. Fibrous tissue is firmly bound to cartilage over all its surface. In three or four places there are small collections of fibroblastic cells, lying in the cartilaginous stroma, which appear to be pushing inward from the surrounding fibrous

tissue. New bloodvessels accompany the growth or invasion of the cartilage. The cartilage consists of chondroblastic cells, in a more or less hyalin matrix, but scattered throughout are deeper staining areas. (Irregular deposits of calcareous material.) The cartilage is normal in appearance except for the fibrous tissue changes in the surface areas. The surrounding tissues are composed of a fibrous tissue stroma and new bloodvessels, with scattered areas of round-celled infiltration.

This piece of cartilage had remained *in situ* for eight months. The wound had healed without infection. We learned at least from this case that there had been no tendency to atrophy, and the cartilage had become firmly united to the margins of the gap. There is a suggestion that some calcareous deposit had occurred, but this, obviously, if it did occur, was extremely meagre and insignificant.

We have as yet little evidence regarding the fate of the bone graft. That changes occur in the bone is brought out in a striking manner in the *x*-ray picture taken of the very large graft, made from the cadaver. The graft was 9 cm. by 12 cm., was composed of the outer table of the skull and was perforated by many holes 3 mm. in diameter. Under the *x*-ray the sieve-like appearance of the graft is evident. An *x*-ray plate taken three and a half months after the graft was inserted shows a gradual disappearance of the holes with apparently some condensation of the tissues in the places where the holes are disappearing. On feeling this man's head the graft is perfectly firm and solid as far as the graft is concerned. This fact, taken with the appearance in the *x*-ray plate, would lead one to hope that the changes which are obviously going on in the graft are such that it will remain and serve to close the hole permanently and successfully.

We have in no instance seen any tendency to absorption of the graft. Judging from experimental evidence and from our own experience we are hopeful that either bone or cartilage, if successfully implanted as a graft in a cranial defect and if the wound heals without sepsis, will unite with the tissues in which

it is embedded and will persist as a permanent and satisfactory closure of the gap.

The Relief of Symptoms by Cranioplasty. We have already studied the relief of individual symptoms in our series. We may now make a general statement as follows: For our purpose we shall only consider the cases in which a completely satisfactory closure of the gap has been accomplished by a firm graft. There were 34 cases in which the operation *per se* was completely satisfactory. The bone graft under such circumstances and the cartilage graft seemed equally efficient.

Cases completely relieved of distressing symptoms	19
Cases rendered worse by the operation	2
Cases improved but not wholly relieved	8
Cases with no change in the symptoms	5
Total	34

Conclusions. It is possible to successfully close a gap in the skull by a graft of bone or cartilage, and thus restore the integrity of the unyielding cranial vault. The operation is attended by little danger to life as shown by the absence of mortality in our series of cases. The relief of symptoms directly dependent upon the existence of the gap is, as a rule, immediate and complete; such as headache, dizziness, the fear of injury and the sense of insecurity, occasionally the worry and mental depression dependent upon the possession of an ugly deformity particularly in the forehead. It is probable that when such a symptom as headache is not relieved, the trouble is dependent upon some condition additional to that of the cranial defect. The gratitude expressed by men who are relieved of these comparatively simple but most distressing maladies and who are rid of their deformity is sufficient guarantee that the operation is warranted.

The value of the operation in more complicated cases, more particularly those suffering from Jacksonian epilepsy, is less evident. Relief has been obtained in some of our cases, as we have noted above, but we can make no useful statement as to

the probable permanence of that relief. On the principle that we should remove all sources of cortical irritation, if possible, in such patients, one might argue in favor of the operation, but the graft itself may be a source of irritation as evidenced in the case of one patient already referred to. In this instance a bone graft was removed and a fascial graft substituted with relief from the convulsions up to the present time four months after the operation. In the majority of our cases of Jacksonian epilepsy some measure of relief was undoubtedly secured. This would be explained by the relief of symptoms directly dependent upon the existence of the gap and the presence of scar tissue causing cortical irritation. We believe, therefore, the gap should be closed in these cases in order to eliminate the symptoms due to the existence of the defect and with the hope that in addition the epileptic seizures may be ameliorated.

The effect of operation on such symptoms as defective vision, aphasia, loss of memory, deafness and other symptoms dependent upon organic cerebral lesions is of little or no value.

The value of the fascial graft is well worth considering. Where there is a cortical irritation, with much scar tissue implicating the dura mater, it is most serviceable to make a free dissection of the cicatricial tissue, removing the patch of dura mater involved and substituting a patch of fascia lata to close the rent. Our cases recorded above demonstrate its usefulness.

Finally, we may conclude by stating our belief that where a gap exists in the cranium it should be closed. The symptoms caused by the existence of the gap and directly dependent upon it will almost certainly be relieved by a successful cranioplasty.

DISCUSSION ON PAPERS OF DRS. VAN DE VELDE, POWERS AND PRIMROSE

Mr. Ernest W. Hey Groves, Bristol, England:

In general terms I am quite in agreement with Dr. Van de Velde in his principles for the treatment of fractures of the lower third of the femur. In certain details, however, I think the matter is still open for criticism. In the first type of fracture in Dr. Van de Velde's classification, wiring is spoken of as a routine measure. My difference of opinion here is only a matter of proportion. I think the number of cases in which wiring is necessary in open fractures of the femur without comminution is limited to the exceptional case. I believe the operation should be limited to those cases in which there is a widely open wound through which, with the help of the *x*-ray, we can prove that the two fragments are so widely separated that there is real danger of the soft parts interfering. A wire can in such a case be thrown around the two parts and the separation quite easily remedied, but I do think that with the efficient extension apparatus available the number of cases in which that may be necessary is very small. There is no doubt that the manipulations necessary to even pass a single wire loop around the fragments considerably delays the progress of the case and should not be undertaken unless it is quite clearly indicated. In the second type of cases in which there is considerable comminution I think we are in accord upon the principles of treatment; that is to say, that it is impossible to obtain adequate extension of the femur, particularly in fractures of the lower third, without the employment of two forces, one force pulling in the longitudinal direction and the second pulling forward to correct the backwardly directed lower fragment. That is, of course, aided by the relaxation of the pull of the gastrocnemius by bending the knee. Before we come to the method by which these two forces can be applied I venture to suggest to you that there are certain grave objections to the employment either of ice-tongs or transfixion pin in the lower end of the femur in the type of case in which there is both comminution and an infected wound. I came to the appreciation of this difficulty in a large series of cases. Whenever there was a wound near the knee I transfixed the upper end of the tibia. I was so pleased with the results that I now employ it almost as a routine, only using the femoral transfixion for special cases. I can almost anticipate the objection you will feel to this suggestion, and I can sympathize with this objection. You will say that it is entirely wrong to deal with the thigh by pulling on the tibia. Well, my

preconception was quite in sympathy with that idea. As a matter of experience that objection is far outweighed by practical results. The two points are these: However, first of all, let me grant, as a matter of mechanical efficiency, that transfixion through the femoral condyles is ideal. I lay no stress at all upon the ice-tongs, that being merely a matter of individual preference and does not involve any principle. The two objections to femoral transfixion that are overcome by tibial transfixion are that whatever method of asepsis you employ, a pin right through the lower end of the thigh is bound to act as a seton, and in a certain definite proportion of cases there will be sepsis, and that sepsis will either go up the thigh in the fascial planes or it will involve the articulation of the knee-joint. In my own series of cases that actual problem of sepsis amounted to 3 per cent. That is not a very large proportion of cases, but the particular individual who happens to be one of that 3 per cent. does not like it and lets you know about it. That danger is entirely eliminated by the tibial transfixion, because there you simply put your pin in and it is only a small one, one-eighth inch in diameter and four inches long. I do not claim for this transfixion any immunity against the seton action of the transfixion pin. You may get it, but if you do it does not matter, because it is not in connection with the knee-joint or large fascial planes, and in the 3 per cent. in which you get infection the infection is easily corrected by a wedge-shaped excision of bone half an inch thick. The other great objection to femoral transfixion has already been mentioned by Dr. Van de Velde. He admitted that you could not leave the transfixion pin or the ice-tongs clamp on the femur for more than six weeks. My experience is that six weeks does not see us through. What are you going to do at the end of six weeks with your sheet anchor gone? You have either to abandon the traction or transfix the tibia. I venture, therefore, to suggest for the consideration of this Association that in a great many cases of the femur, and particularly pin fracture of the lower third of the femur, that it is of the greatest possible value to transfix the tibia and put on a weight extension. Just a word of caution—when cases treated by a method you have suggested go wrong your friends are always kind enough to tell you about it. I have heard of only one case, though there may have been others, in which the knee was injured. In dealing with a recent case of fracture of the femur the only object in traction is to overcome the pull on the muscles. In an old case, or a case with vicious union, you must either reduce that by a big pull or transfix through the femur.

Dr. John B. Walker:

It is too early to give the end-results of fracture treatment at this meeting; however, it is only by learning what these end-results are in all cases that we can ascertain which treatment is the best. The treatment of gunshot fractures of the femur is one of the subjects which has benefited the most from the progress which has been realized in the course of the war.

From the experience of Mr. Groves, I believe that what he has said regarding transfixion is true.

For transport of the patient from the field to the evacuation or base hospital the Thomas is the best type of splint. During the presence of infection the Thomas or Hodgen splint used with the Balkan frame, with extension by suspension and traction, has given the best results. For many fractures of the lower third of the femur, with backward displacement of the upper end of the lower fragment, no type of splint has proved so generally efficient as the caliper. By the Germans in 1914, 1915 and 1916 the Steinman pin was used extensively, more so than by the British and French. During 1917 and 1918 there was a great increase everywhere in the use of the caliper.

I wish to take a moment to speak about the records of our war injuries. These are not now available for study by our members, and our Association should express its wish to the Surgeon-General that it is most desirable that the War Office take such measures as will render these valuable records available for research to our profession. In England the National Research Society of the Red Cross is collecting the records of the British casualties in the British Museum, and making great efforts to render them available for research. In France similar efforts are being made and equal advantages should be assured by our own Surgeon-General.

Dr. Joseph A. Blake, New York:

In the treatment of fractures of the lower end of the femur I have frequently used the tibial traction by means of a transfixion pin at the tubercle, and it is safer, perhaps, from the standpoint of infection, because necessarily in war fractures the wounds extend far down toward the knee and often interfere with the application of tongs or a pin in the femur. But in tibial traction we lose control of the lower fragment, which is an important element in the treatment of these fractures. In every case in which it is practicable to place traction upon the femur we should do it. I have found that the ice-tongs have done the least harm in the matter of causing infection or keeping up infection. There is a little point which I should like to emphasize in regard to the control of the lower fragment, and which

supplements the point made by Dr. Van de Velde. He spoke of introducing the pin at a high point. This point should be as high in the epiphysis as is possible. In treating a fracture of the femur the first thing to overcome is the longitudinal displacement. I want to say that in all cases of fracture sufficient traction weight should be put on to reduce the fracture within a few hours. This should then be lessened. It is the continual adding of weight to inefficient weight which produces relaxation and lengthening of the ligaments of the knee when traction is made on the tibia. If the traction is put on with efficient weight and then lessened we seldom meet with this difficulty. With high implantation of the tongs or pin, as soon as longitudinal displacement has been overcome by traction made in the axis of the proximal fragment, if we then shift the direction of the traction to a point above the axis of the proximal fragment we can in a great many cases lift the distal fragment into position and obtain perfect reduction. I have found this to be a very practical point. With pin-traction through the tibia we have an entirely different principle of treatment. We then have to pull in an arc over a fixed point in order to lift the distal fragment up into place. It is, I believe, more than probable that the application of these principles will be easy in civil fractures and that the use of the ice-tongs will be the most efficient solution of the problem.

In regard to Dr. Powers's paper, I shall mention one case of three I had in the American Ambulance in the early part of the war. Of this one I saw an *x*-ray three years afterward, showing a perfectly solid jaw. I found in this case much difficulty in chiselling out the seat for the inlay graft. By using a specially constructed hollow mill the place for the graft can be easily cut out without any strain upon the splints used for fixation of the fragments, which is unavoidable when a mallet and chisel are employed.

Dr. Thomas W. Huntington, San Francisco:

Treatment of fractures of the lower jaw and associated injuries offers a field of surgery demanding a degree of human faith and patience which pertains to very few of the activities of the surgeon. One must here follow the injunction of Emerson, that to accomplish most things worth accomplishing in the world you must have your ideal, and your ideal may be beyond the limits of your horizon—over a mountain—if you please, and you have got to wait patiently, day after day, week after week, month after month, as shown by Dr. Powers, before you reach your goal. I know of nothing which requires more patience and faith than this particular work.

Sir Arbuthnot Lane, London, England:

I have had considerable experience during the last four years in watching the evolution of what you might call jaw surgery. We were fortunate in having in the Queen's Hospital, Sidcup, a large institution in which thousands of cases of injury to the jaws and bones of the face passed through our hands, and where we had not only eminent British surgeons, but some of the most expert plastic operators of the allied countries. It is a matter of very considerable regret to me that Major Waldron, C.A.M.C., who looked after much of this work and who was present here until yesterday, is absent from this meeting, because he could tell you much more about the details of the work than I can. The treatment of fractures of the lower jaw differs largely from that of fractures of the extremities. We have for many years been putting grafts to fill gaps in fractured bones in the extremities, etc., and have had to take the utmost precaution against sepsis. After fractures produced by projectiles we had to wait a long time until any evidence of the presence of sepsis was eliminated, and the proper time for operative interference caused us in almost every case a certain amount of anxiety. In fractures of the lower jaw the conditions are much less difficult, since it is possible to graft at what would appear to be much too early a time in the case of a long bone. This is probably due to the greater vascularity and to the increased vitality of the tissues of the face. Even if there is mild sepsis in the wound made to repair a loss of substance in the lower jaw, the graft does not necessarily come out. A piece of bone will live and grow in the lower jaw if it is functioning. A graft insecurely fixed between fragments will probably atrophy, and may disappear completely. Other remarkable features of war surgery have been the forming of eyelids and lips by making large buried inclusion epidermal grafts. If you do away with dead space between the tissue and graft every bit of epithelium will grow. This plastic work was started by Major Gillies at Aldershot and was continued by him on a very large scale at Sidcup. He had associated with him Colonel Newland of Australia, Major Pickerill of New Zealand and Major Waldron of Canada, and other men of great skill, originality and judgment. It is difficult to praise too highly the work done at Sidcup and the physical advantage and mental satisfaction that was afforded to these poor disfigured cases. I again express my regret that Major Waldron is not here, feeling as I do that he has done more for the treatment of fractures in this war than any one else up to the present time.

Dr. Charles A. Powers, Denver:

I have apologized in the beginning of my paper for the small number of cases reported, but I find no record in medical literature of any large number of operations. As to the introduction of a bone graft in infected tissue in any part of the body for pseudarthrosis, it is dangerous and fallacious teaching, and those who practice it will generally fail.

NOTES ON AMPUTATIONS AND STUMPS

By FRED J. COTTON, M.D.
BOSTON, MASS.

The subject of amputations is so large and so little has been done about it that one hoped the war would solve many problems and standardize practice.

The vast number of cases concentrated at relatively few bases, the apparent opportunity for centralization and follow up, the freedom from the restriction of patents and from the insistence of the commercial limb-maker, the presence of centralized bureaus for study of the problem and of the cases, seemed to offer vast advantage over the hit-or-miss methods previously in vogue. For in fact before the war few of us saw more than a half-dozen or dozen amputations in the year, and, to be frank, we did not see these through, all the detail being left to the limb-maker—ingenious artisan, but hardly judicial in his point of view.

There have been, I am told, about 3500 amputations in the American Army.

Have they been better handled than those we had before the war? I hope so, but am not sure. Have they taught us anything? They surely have—both ways!

In this, as in many other matters of war surgery, we have not arrived at the counsel of perfection but have gained perspective—and some bit of wisdom.

For excellent instance, we have learned that the most admirably ingenious artificial arm is of no value to the man who cannot be brought to take the trouble to learn to use it.

For further instance we have learned that the problem of arms is that of the left arm. Just 100 per cent. of men who have lost

a right arm become "south-paws." It is easier to educate a live arm than an artificial one. Right or left, the new arm is a left arm, and is to be considered only in its capacity to perform those auxiliary functions we demand of our own left hand and arm.

This factor, understood, neatly wipes out several months of study as to ideal function that occupied certain officials for some months.

We have learned (what we suspected before) that certain pretty amputations are "no good," that a certain few are serviceable, and we are in position to translate cases from one group to the other by operation without wasting time.

We have learned that end-bearing stumps, perhaps ideal, do not work out in practice—*exeunt* certain other months of research and consideration at headquarters.

We have learned that a very ugly-looking scarred stump may be a very good stump; and some of us have learned that a long, poor-looking stump is likely to be better if we let it alone instead of shortening it.

We have learned that scarred stumps must be handled radically or let alone on pain of slough and sepsis.

We have learned that with an open stump after operation (or at any time) traction will give us 2 to 3 inches slack, and that flap-traction is, in the rule, far better than bone-shortening.

Some of us have learned to regard with suspicion every proposal of reamputation and have seen some hundreds of stumps that were at least short enough.

My own attitude in this regard was put on record some months ago.[1]

We have learned that irregular bone-ends may do very well.

We have learned that tight-pulled stump-ends, "cauliflower" stump-ends, scarred stumps, red or purple, ill-nourished or eczematous, do badly—much worse than their appearance suggests—and often may need operative interference.

We have learned what the Carrel-Dakin treatment can do in active infections, or in cases not very septic but not healing,

[1] Lengthening of Stumps. F. J. Cotton, Major, M.C., U.S.A. The Military Surgeon, May, 1919.

and we have learned the necessity of exact detail in this work if it is to be of any value at all.

We have learned the uselessness of stiff, contractured stumps and the value of physiotherapy—*early*—in these cases and of proper exercises.

We have learned how to do forcible reductions and muscle-plastic operations in neglected contractured cases as well as the plastic operations obviously suggested by broad and tender or tight cicatrices.

To come to detail!

I am speaking from experience only at home and confined almost entirely to the cases at Parker Hill (U. S. A. General Hospital No. 10) and at Walter Reed General Hospital, with a bit of experience at the Washington Orthopedic Headquarters during the study-period of the summer of 1918.

As to stumps:

I. The proper stump—in general the ideal—is one with a free but not very loose cap of soft parts (we of the United States use muscle also; our British confrères are content, it seems, with covering formed of skin-flaps, only), joined by a narrow, loose-sliding scar away from the pressure-bearing surface—a bone-end smooth, without "spikes," and nerve-ends not sensitive or barely so, and out of contact with the weight-bearing or pull-resisting structures.

Such stumps we hardly met with.

The rule was the "guillotine" stump, not a real choice, but the selection along lines of least resistance. I cannot recall seeing over a half-dozen war stumps that seemed to me to indicate choice in the point of amputation.

Naturally, most limbs under the unavoidable pressure of near front-line conditions were chopped off above the obvious damage and left open.

Naturally, not a few of these failed to get the ideal treatment of disinfection (Dakin) and of flap traction.

Naturally, nearly all of them came out shorter than one could have desired, often with slow-healing wounds, with tender neuromata, tense scars, etc.

As a rule, the stumps we got back on this side were so short that nothing could be spared in length.

Upper arm stumps under 3 inches are useless[1] or nearly so. Elbow stumps should have $3\frac{1}{2}$ inches below the end of the olecranon to be of real value. In thin arms 3 inches may be worth saving. The determining factor is the insertion of the biceps; the deciding question is whether biceps contraction will push the artificial arm off the stump.

Now in these upper-arm cases one devised plastic operations to get around the difficulty.

If one has a 3-inch upper arm stump, one may lengthen it, so to speak, by shifting the pectoral and latissimus tendons upward.

This was done in many cases, particularly with the pectoral. A slicing of the pectoral insertion for $\frac{1}{2}$ inch upward or a plastic operation that cuts and turns over the lower part of the tendon to the upper (sutured into its new place) sacrifices no important power and gives a stump of some real value.

This was done many times, with gain.

In certain cases it was obvious that proper traction had not been carried out or had failed (owing to transfers, etc.), and in these cases excision of the massive scar and institution of proper traction, even late in the game, gave results. This was not often needed but worked out well when needed, both in arm and leg stumps.

In a few cases of unhealed stumps it was evident that tension was the troublesome fact, and traction applied without any loosening of flaps brought about prompt healing.

Such traction is easily applied with adhesive straps or with flannellette bandages fastened with Heusner's or a similar glue. The pull may be by weights or elastic bands, but traction by cords, tightened with the Spanish windlass, is ordinarily enough. The Thomas splint, of one or another type, gives the counter traction.

It is surprising to see what an amount of slack can be gathered up by this traction in a few days, and without discomfort to the patient.

[1] Measured from axillary fold to end.

In stumps too wide open for this treatment one may do plastic operations.

I have taken,[1] and still hold, a strong stand against shortening any of the already too short stumps.

Not a few cases can be covered in by reasonably ingenious plastic operations, utilizing the surrounding skin, after the flaps have been loosened by a week or two of traction or by vibratory massage and manual traction.[2]

In a few cases this cannot be done, and in these a two-stage flap transplant will do the work. The technic of this operation I have detailed in the note in the *Military Surgeon*, already referred to. The operation works out perfectly well if proper technic is adhered to.

Some of my friends have had failures, due, I think, to insufficient preparation of the edges of the flap and failure to cut back to sound tissue or to neglect of proper apposition of edges or to the use of too small a transplant.

I wish to reiterate my conviction that there can never be any justification of further shortening of a stump already too short while we can do flap-grafting. (See Figs. 1 and 2.)

There are three other causes for plastic operations besides the too short stump.

1. Scar Tension: By this is meant the tension on scars not terminal or but partly terminal, which drag on bone, nerve or even only on skin. Such stumps giving or threatening trouble always call for plastic work.

2. Inturned Scars: The worst sort, the "cauliflower" stump, full of deep creases, absolutely call for reshaping and in most cases even simple, deep clefts are so hard to keep clean, so apt to macerate that most of them are best eradicated.

3. Eczema: Half of these belong in class 2, because it is maceration in folds that starts the other trouble; the others depend on poor skin and friction or have hung over from the dermatitis of

[1] Cf. Cotton: Military Surgeon, May, 1919.

[2] Massage is essential in nearly every stump—to improve circulation and to loosen tissues in and about the scar—and this altogether aside from the need of massage for limbering up adjacent joints.

sepsis or excessive chlorinate or other medication. Of whatever source, however, they show the terminal scar or its edge as the minimum point of resistance or repair, and often the maximum of infection. In a quiet interval such a stump may most profitably be cleaned up by a plastic, whether it is also badly shaped or not.

FIG. 1.—Unhealed end of short forearm stump, the result of "guillotine" amputation.

In all plastic operations on stumps there is one limitation we must never forget. Only in the rare cases is one justified in doing any operation that does not include total excision of the scar.

These scars may or may not carry latent sepsis, but at all events they are hard, dense and very ill-nourished, and their resistance to infection and their repair power are at a minimum.

Operations through scars slough often and carry a heavy percentage of sepsis—not in itself serious, as a rule, but enough to spoil the job.

The general rule then is:

Excise the whole scar or let it alone. This applies to transplants as well as plastic operations.

In operations for some other things, one evades total scar excision by cutting through sound skin at one side and doing a burrowing operation, with little risk, even if scar tissue is cut into from underneath.

FIG. 2.—Same stump after covering in with two-stage flap-graft from the flank. Stump not shortened, but lengthened about three-quarters of an inch.

Operations for bone lesions:

1. For sequestra:

Sequestra were common. As a rule, all that was needed was to fish out the sequestrum through a stretched-up sinus, no cutting, or very little, being called for. Sequestra once out, the wounds usually healed promptly with or without Carrel-Dakin treatment.

2. To clean sinuses without macroscopic sequestra. Many cases had bone sinuses—sluggish, calling for curettage. After cleaning out and providing real drainage these stumps were preferably treated by the Carrel-Dakin technic. The tendency in such cases is to do too much.

3. Operations on bone for bone spurs were not common. As a matter of fact there may be considerable overgrowth of bone, even in spurs, without making any trouble.

Here and there spurs need trimming—a very easy job—consisting merely of going in around the corner through sound skin, knocking off the spur with a chisel and pulling it out.

That is all there is to it even when operation is called for.

4. Operations for nerve involvement.

Nerve-involvement usually means excising palpable neuromata—less commonly excision of a nerve not obviously abnormal but in the way of any pressure from an artificial limb.

In the war wounds, practically none of the cases had had the nerves cut back.

Neuromata were common.

Some few neuromata palpable but only vaguely tender and not in the way were let alone.

In a couple of cases I did an L-shaped amputation of the nerve, turning in the flap to give enough nerve-end, but do not believe this worth doing, for we had no recurrence of neuromata after simple resection.

In some few cases nerves were resected, not for neuromata but because the trunk was caught in the scar and subjected to tension, especially on movement.

Massage, Hydrotherapy, etc.: Nothing more important; never a stump of the type we got, late, that does not need prolonged, frequent treatment by a really skilled physiotherapy aide.

The objects—results to be attained and routinely expected—are:

1. Diminution of sensitiveness (save in cases with neuromata regularly made worse if one massages them). This is of decided importance—a real part of the general process of hardening of the stump and often a means of doing away with some local tender point.

2. Improvement in general nutrition—a result of massage so familiar in all sorts of cases that one need not particularize here. Cultivation of muscle-mass is no part of our object in stumps, so the massage for nutrition may well be superficial massage.

3. Specifically, promotion of wound-healing in stump ends. No longer may we regard the presence of a wound as contra-indication to massage any more than to the wearing of a trial limb. Danger of infection is slight. Wounds can be covered and protected and the benefit of physiotherapy is too important to be postponed.[1]

4. Removal of the products of infection, to the end that recurrence of infection is made less likely and that spongy, edematous stumps take shape. This change in the stump must often be waited for. Until it is secured one may do no operation on a stump save for removal of sequestra or for such things as need doing directly in order to secure the closure of wounds persisting unhealed.

5. Loosening of tight stump tissues: Marvels can be accomplished in this way. Kneading massage is the rule. Vibratory massage, requiring a good many hands in the clinic, is of value, provided the aide can do it. Not all can, and it is tiring at best. Have seen nothing of the results of mechanical vibration on stumps and should be loath to try it, good as it is in certain other conditions.

6. Actual lengthening, bringing down of flaps, either to bring about the end-result, the usual sequel, or in order to make possible the plastic operations without shortening on which so much stress is laid. Massage alone will not do this as well as traction alone, but greatly aids the speed and comfort of the process; traction all the time, save for a daily massage, is the program.

Massage and bath-treatments need no great caution.

Stretching of stumps, *i. e.*, the mobilization of the joint proximal to the amputation.

[1] In these unhealed wounds, combination of hot and cold baths with massage helps. Further, in some cases the ultraviolet ray does help. Owing, however, to the ease with which overdosage of the ray leads to dermatitis or even to slough of the devitalized scar tissue, this method is to be used with caution by experts only.

By simple manual stretching with preceding massage to loosen tight muscles, one may accomplish wonders in this regard.

Very many of the stumps were very tightly held in vicious position, particularly the upper arm stumps, and had been so held a very long time until cure was difficult.

As noted above, many of these cases were the better for a bit of muscle and tendon plastic, which both cleared motion and gave a better shape to the stump; but such operations were always preceded by massage and stretching for a time and followed by further stretching.

The average case, whatever the amputation, was cleared by manipulation alone until the point was reached where active exercise was in order, and even after this.

In only one case of ours was any machinery needed—in this case a double thigh amputation with short stumps—a stretching table was built to provide for fixation of the pelvis, and for the dragging back into extension of the stumps by slings over them running through slots in the table and down in loops in which the operator's foot could exert the downward push.

In few cases was stretching under ether employed, the ordinary persistent efficient work of the "P. T. aides" rendering this unnecessary.

At times persistent stretching, *e. g.*, the straightening of a knee by bandaging it back against a ham-splint, was resorted to.

Stump Exercises: With us, free exercises, freely resorted to, under the guidance of the aide, and a very limited amount of stump drill in squads, made up of men similarly crippled; occasional sporadic efforts to get up simple competitive games. This was about all for the arm cases. Beyond this a little was done, not enough, I think, to interest the men in using artificial arms (or more often temporary prostheses) in playing anything from ping-pong to pool. The value of this work is in its interest. Men of our country with developed sporting instinct play harder than they work, often, and a man will do more in a competition of one-handed pool-players than at the bench.

It was a pity that the opportunity of large groups of men similarly conditioned was not better used to establish a useful routine

along these lines. It was better done in Canada, I think, and I hope further developed elsewhere in this country than in the centers I was serving in and those I saw.

As to leg exercises, we used only those carried out with the pilon or temporary leg, and exercises carried out in connection with massage and stretching. The exercises done with the fitted legs, in squad or singly, over obstacles or on the road, are of obvious value; but men learn so quickly, as a rule, that they need not be elaborate or long-continued.

For leg amputation this seems adequate. It is in relation to the arm cases we should have done more.

So far as gaining motion goes, stump exercises can do little more than bring within voluntary control the range of motion gained by manual stretching, but their value in education of brain and stump goes far beyond this.

Occupational Therapy and Vocational Work: In theory these measures should be of value, and I believe very thoroughly in them, for other classes of cases, but I do not believe that with us they had any great value, probably less than the play efforts where such were made.

It seems to me that the work done in the shops for the arm cases was excellent so far as it went. Development of routine along these lines was simply crowded out through no one's fault.

Early Prostheses: The greatest progress made on the whole was in the use, very early, of temporary limbs.

The form of temporary limb is unimportant.

What is important is the early use.

1. It aids greatly in securing shrinkage of the stump to its permanent form.

2. It toughens the stump, often tender at first.

3. It avoids the formations of contractures, helps overcome those present.

4. It helps build muscle with which to handle the limb.

5. It helps morale.

6. Most important, it counteracts effectively the tendency to forget the limb mutilated, the tendency to let the central motor tracts belonging to the limb waste and lose their place in that

delicate nervous mechanism by which we do most of our so-called voluntary movements throughout our lives without any conscious volition as to details of motion.

If a man carries a leg stump unused until it heals after months, he must learn to walk again, painfully, clumsily—if he has a pilon within a few weeks he has never had a chance to forget.

If one carries a useless arm stump for months the effort of learning to use it again, even with an efficient apparatus, looms so large that only the man above average in sense and will-power is apt to carry it through. It is so much easier to use one hand for both, for many things, than to educate the almost forgotten limb.

This principle was accepted in our army work very early, and so far as concerns the leg amputations, efficiently carried out in many cases in a number of centers.

The first temporary limbs were French pilons, then American-made ones, lighter and a bit better, for low and high cases both; and then, not because they were much better but because the boys preferred them, the light temporary artificial legs for the amputations below the knee and for some of the thigh stumps.

The more important thing is not the question of pilon or leg but the matter of handling the stump socket.

A number of ways differing in detail were devised at the various centers, all leading to the same end. The method to be described here was developed at the Walter Reed General Hospital and should be credited to Captain Yount.

With the artificial leg of the temporary type ready, a leg consisting of a foot and ankle depending for motion on a hinged joint at the ball of the foot, and one at the ankle, both working against inset pads of sponge rubber, with a knee-joint at proper height and leather cuff (laced) for the thigh, the case is ready for the socket.

For this we have first a stump-sock, of the cotton-flannel-like stuff, fluffed on one side, which is sold as "eiderdown." Into this sock (turned smooth side out) is put a cardboard form to keep the sides apart and the whole is put in a pan of rather soft paraffin (heating over a water-bath) until it is saturated. Then

it is fished out, opened up, and as it begins to cool to a tolerable point it is slipped over the stump, pulled up snug and modelled as it hardens, so as to fit the stump as the stump shapes itself under a little pressure. Especially is the stuff modelled close home over tuberosities, spine and front of the patella where the weight is to be borne later. The hardening is hastened by slopping with cold water. When it is set it is solid. Then the rigid form is supplied. Plaster-of-Paris bandage will do, but if the plaster in the bandage is replaced by Bielotti's mixture or Kane's cement it is more durable.

The wet bandage is wrapped around the hard, dry paraffin core, to which it adheres, and when it sets the whole is removed.[1]

If it is desired to protect the stump-end, as in cases recently healed or unhealed, the whole thickness can be cut way at the end as desired, for we are not dealing with end-bearing stumps at all.

When the shell is hard the soft-tempered side-bars of the leg are bent to fit and the stump cast is riveted to them at proper height.

That is all. The leg is ready for use, and if not too long a time has elapsed since the amputation it is wonderful to see how quickly the patient uses it and how quickly he gets rids of his limp.

The stump shrinks promptly—a stump sock of the usual type takes up the slack.

It shrinks more; a fresh stump socket is prepared, a matter of only a few minutes' work, and the leg is again ready for wear, fresh fitted the next day.

This may be repeated several times, but when the shrinking is over this stump socket will last for months and the temporary leg is, in fact, nearly as good as the permanent one.

The skeletonized leg we used to complete with a roll of binder's-board below to give a leg shape for the sock, and with this rig the men used to go on leave to town, most respectable in appearance and with hardly a limp, often before the stump was fully healed.

[1] If desirable the paraffin cuff alone is stiff enough to take off and then add the plaster shell at leisure.

A like scheme was used with thigh amputations or with part of them.

In thigh stumps the weight is not borne on the sides of the stump to any considerable extent, as it is with stumps below the knee, but on the tuber ischii and in the perineum. In many cases a temporary limb with a properly fitted ring at the top needs no special stump-socket. The laced flaps over the thigh give enough compression and fixation for the convalescent stage. Moreover, the thigh stump is pretty shapeless, as a rule, in itself and needs modelling of the stump, not fitting to the stump.

Often, however, the stump socket works best modelled just as for the leg, close up to the crotch and up under the tuber ischii, with an outward roll of the paraffin and of the plaster to carry the weight at these points.

Oftener than with the leg, thigh stumps do well at first with the lighter pilon, simply a square crutch-tip and two lateral strips of maple, about $1\frac{1}{2}$ by $\frac{3}{16}$ incorporated above in the plaster of the socket.

They are lighter, better, I think, to learn to walk on, but the patients dislike them as unsightly, which factor has unduly limited their use.

As to arm prostheses, for unhealed stumps a stump-socket of paraffin and plaster is sometimes of use. As a rule, however, here as in the thigh, compression in a fixed laced cuff of conical shape works better, for in the arm also there is no end-bearing problem.

There was developed a very excellent stock forearm prosthesis, a tubular conical affair of binder's-board or leather, with lateral irons carrying an end-piece, with a chuck to take the "Sunday hand" or a tool.

For long forearm stumps this needed only a cuff above the elbow connected with lateral straps to the lower part.

For the less good stumps an elbow-joint and lateral irons fastened to the cuff for the upper arm were needed.

For arm stumps there was the short leather cuff like that for the forearm, with side bars carrying an end block and chuck at the elbow level, or hinging to a forearm member, which could be flexed by the tension of a cord running over the forearm

and to the thumb if the stock hand was used. This cord ran to the back of the chest strap. Slight abduction at the shoulder in this way would flex the forearm, or, with the forearm straightened, would open up the thumb away from the rigid hand.

The upper arm in any case was held on by the straps. After we had learned better no shoulder caps were used, the straps running front and back connected above the shoulder and running to their junction through the opposite axilla.

These forms of apparatus were well tolerated and did good service in shaping stumps.

In many cases they were refined by the making of special appliances and tools to go into the chuck at wrist or elbow level.[1]

This was all nice work mechanically and should have given results.

So far the consideration has been of the temporary prostheses. As to the more permanent apparatus, not very much need be said.

The permanent limbs, technically permanent ones, were not supposed to be fitted in army hospitals but were the care of the war risk bureau. As a matter of fact enough limbs of the various more permanent types were fitted and tried out to give a fair perspective.

So far as leg amputations go the matter may be dismissed very briefly. Save for better wearing qualities they do the same service as the temporary types.

In a leg amputation with any sort of decent stump one can walk, can walk early and can walk a good deal, and can walk with little limp, not rarely without any.

The thigh amputations well-fitted do almost equally well, but have not the same endurance in walking, and at best nearly always have not a limp but a more or less stamping gait, suggesting an early one-sided tabes.

[1] For shoulder-stumps as for hip-disarticulations little was done. These were regarded as cases for the special arms or peculiarly fitted hip buckets etc., and were sent to the limb-makers, rarely treated prosthetically at the army centers.

As to the arms it is different.

One has seen marvellous things done by men who had lost both hands, but these cases have been the end-result, not only of specially careful fitting but even more of special and long-continued practice.

One has seen one-armed men doing wonderful things with an artificial arm, but most of them have been demonstrators, and none that I have seen have been from the A. E. F.

The first fact is that most men will not take the trouble to learn to do "stunts" with artificial arms. And the second fact is that they are stunts, for the one-armed man. I reached the point where I no longer blamed the men. The best artificial arm can be a left hand—never anything better—always slow, clumsy and not very strong, and if it is attached to the right arm the patient finds it practicable and necessary to become left-handed and to use the right as a secondary hand.

We made a mistake in not recognizing this earlier, for the real practical problem is of the man who has lost one hand. What he needs is something with which he can do rough things, can hold things he is working on, etc.—something like the Boller hook or the Keller hook or the Everson arm, or a chuck for special tools, if he is an artisan.

If we try to make him do more he usually does less, and confines his work to using the bare stump—often skilfully—and regards no apparatus as worth the trouble save for pure show.

This is a sad statement, but I have seen too many hands in which the thumb mechanism was of value only to clamp the arm to the head of the bed while the wearer went without.

One man had his so attached to the bed as to make the socket a receptacle for flowers, which appealed to me as a memorial to all that we were going to do with these arms.

Some day somebody is going to make a practical artificial arm. I am sure of it.

SURGICAL PROBLEMS IN THE RECONSTRUCTION OF PERIPHERAL NERVE INJURIES

By CHARLES H. FRAZIER, Lieut.-Col., M.C., U.S.A.
PHILADELPHIA

In so far as concerns the injured of the American Expeditionary Forces, the surgical treatment of peripheral nerve injuries did not begin, with few exceptions, until the soldier became a patient in one of the general hospitals on this side of the Atlantic. That the management of peripheral nerve injuries was a problem distinct from other surgical problems was recognized by the Surgeon-General by the following: Under his direction twelve hospitals were designated as peripheral nerve centers, to which all patients with these lesions were ordered transferred from the ports of debarkation. To each of these centers was assigned an officer experienced in neurological surgery, and a consulting neurologist, and for each a uniform equipment for the examination and treatment of nerve injuries was provided. As further evidence of the importance of the peripheral nerve problem the Surgeon-General appointed a consultant in neurosurgery and a peripheral nerve commission.

In order that the results of the examinations, the methods of recording the clinical findings, and the clinical records themselves should be as nearly uniform as possible, esthesiometers were designed for the various centers with which to test sensory disturbances, and record in terms of grams, and a special peripheral nerve register was prepared and distributed, with instructions as to how the various clinical findings should be recorded. With this preparation, the peripheral nerve commission will be pro-

vided with the records of all peripheral nerve cases, which, from the standpoint of uniformity and completeness should be as nearly perfect as is possible under the widely variant conditions in the different hospitals. While many examinations by competent neurologists were made on the other side, with few exceptions none of the records accompanied the patient to his destination on this side.

Up to the present time it is estimated that there are over 3000 peripheral nerve cases in the peripheral nerve centers. Of this number the largest collection, 550, have been admitted to General Hospital No. 11, which has been my headquarters, and my remarks on the surgical treatment will be based on my experience with this group.

Of this number up to date 275 have been discharged, as recovered, to convalescent centers, 75 have already begun to recover function spontaneously, 150 have been or will be operated upon and the remainder are under observation.

At the second annual meeting of the Inter-Allied Conference, held in London, May 20, 1918, Professor G. Verga, presented a report of 1000 cases in which only 160, or 16 per cent., had been operated upon. Comparative statistics are not of much value, since there may be wide variation in the character of cases in different centers, but I should regard 25 to 30 per cent. as a reasonable, conservative estimate of the proportion of cases in which operation is justifiable.

Only to those who have been burdened with the responsibility of conducting a peripheral nerve clinic will the magnitude and multiplicity of problems present themselves in their true proportion. The technic of examinations, the proper interpretation of the clinical findings, their proper evaluation, the decision for or against operation, the direction of treatment during the period of observation or recovery, apart from the difficulties of the operations themselves, these are all matters requiring time, experience and judgment.

It would not be possible in the allotted time even to mention many phases of scientific and practical interest, the peculiar

sensory and motor phenomena in relation to partial and complete lesions and to recovery, the consideration of muscle tone and Tinel's sign, the trophic disturbances, the pathology of peripheral nerve lesions and the question of regeneration. So that I will restrict my discussion to those matters which relate solely to the surgical problems involved.

The first question for consideration is the time of operation. How long should one wait for evidence of spontaneous recovery? It has been my practice to wait at least until three months have elapsed from the date when the wound was healed, and in most instances by observing this general rule it is found that at least six months have passed since the injury was sustained. If at this time there are no signs of spontaneous recovery on the one hand and there is substantial evidence of a complete nerve interruption, whether or not this is interpreted as an anatomical division or a central neuroma, there are no grounds for further delay. One must not be deceived by the action of supplemental muscles which may compensate for the paralyzed muscle, as in one instance I recall when the ward surgeon reported to me six months after the injury that a patient with a complete median and ulnar paralysis could flex the wrist, and asked to have the operation postponed. An examination revealed the fact that the patient had learned how to flex the wrist with the short extensors of the thumb.

Assuming, however, that the wound heals promptly, as in wounds from machine-gun bullets, should an operation be advised, no matter how early, providing there is evidence of a complete nerve block? Captain Alexander, at the Adler Hey Military Hospital, Liverpool, maintained that cases sutured within four months of the injury do not do as well as those sutured after the sixth month, probably because degeneration was not complete in the peripheral segment. Whether this be true or not, the mere fact that many cases do not show signs of spontaneous degeneration until about the sixth month is, I believe, sufficient justification for deferring the operation at least that long. I am quite aware of the fact that the results of primary

suture are better than those of delayed suture, *ergo*, the sooner the operation the better; but I also know that it is quite impossible to distinguish, with absolute certainty, by any single clinical sign or syndrome between a complete but transitory physiological block and a complete anatomical division. If the general dictum, as advocated by some, were observed, namely, to operate as soon as the wound permits, with evidence of complete physiological division, many a case would be explored which eventually would have recovered spontaneously, and resection and suture would not only have postponed the time of eventual recovery but might have been totally unsuccessful.

As to matters purely technical, certain general principles should be observed. The tourniquet should not be used routinely, but in the exceptional case, with massive cicatrization of the tissues, much time may be saved in the preliminary dissection if hemorrhage is controlled with a tourniquet. This should be removed before resection or suture; in the interval all bleeding is controlled. Liberal incisions are essential, as the nerve must be exposed and often liberated far above and below the lesion. Traumatism to the healthy portion of the nerve is to be avoided, and to this end I have found it advantageous to operate under a constant spray of saline solution, which keeps the field clear, and if sponging be necessary, use small, moist, cotton pledgets. The preliminary dissection is the most tedious of surgical procedures. It may be carried out with a small, sharp scalpel, or, as I prefer, when the nerve is embedded in scar tissue, with small curved eye and tenotomy scissors and fine fixation forceps. Unless one begins well above and below the lesion, the identification of the different nerve trunks, from one another or from thrombosed vessels, particularly in the upper third of the arm, may be quite impossible. Only with continuous scrutiny will one avoid severance of important rami.

While the preliminary dissection or disentanglement of the lesion is tedious and time-consuming, it is the choice of procedure and the method of dealing with the lesion where experience and judgment count. This brings me to the consideration

of the various operative procedures, neurolysis or liberation, resection and suture, and the various suggestions for dealing with large defects.

As the least complicated, neurolysis will first be considered. In proportion to the total number of operations we have performed a neurolysis in 20 per cent. The figures correspond to the experience of other clinics, although in some, as in a series recorded by Verga, there were 80 neurolyses in 160 operations, or 50 per cent., and in the series of Delangiére[1] there were 113 liberations in 245 operations. It is not always easy to make a decision in favor of neurolysis as against suture. When there is a constricting band, with grooving of the nerve, or when there is compression and a narrowing of the lumen over a greater distance, when there is evident pressure from callus, a spicule of bone or aneurysm, these admit of little doubt. Neurolysis is clearly indicated (and one should always give the nerve the benefit of the doubt) when it responds promptly to faradic stimulation. But in a number of cases, and I have often found this the case with the musculospiral in addition to compression from external causes, there is an associated sclerosis or fibrosis of the nerve, which of itself may inhibit regeneration.

It has become almost a routine practice to recommend resection and suture in the presence of a spindle-shaped neuroma. However, bearing in mind clearly the pathology of the neuroma, it must be acknowledged that the neuroma, *per se*, is not an absolute barrier to the growth of neuraxes. It represents, to be sure, an effort by nature toward regeneration against difficulties but not always ineffectually. The development of a neuroma in cases undergoing spontaneous recovery is not uncommon, and it is not infrequent after suture or transplantation. Huber found in a neuroma, resected in this clinic from the sciatic nerve, such an active growth of neuraxes that he considered spontaneous recovery in this instance would not have been out of the question. If the presence of a neuroma cannot be the indisput-

[1] Bull. et Mém. Soc. de Chir. de Paris, 1918, xliv, 522.

able criterion, the final decision must rest upon the time which has elapsed between the injury and the operation and upon whether the nerve responds to faradism. The decision will in all cases be more or less arbitrary. If there are signs of total loss of function at the expiration of six months, resection and suture are justifiable. Joyce[1] takes exception to this recommendation; the resection of a spindle-shaped neuroma is not justifiable, he says, unless failure has resulted from a neurolysis capsulectomy at which the thickened portion of the sheath has been removed. In this conclusion I cannot concur.

The technic of neurolysis should include the freedom of the nerve from the cause of compression, the cicatricial band or the more extensive scar tissue, dissecting the nerve free from the callus in which it is engaged, such as one often finds in musculospiral palsies. We sometimes find massive fibrous infiltrations of the sheath itself, and an attempt should be made to remove as much of this thickened portion of the sheath as possible, but not to the point of laying bare the fasciculi. In the reconstruction of the wound the ideal and natural bed is an intermuscular plane or a plane between a muscle sheath and the deep fascia. To surround the nerve with flaps taken from adjacent muscles is not good surgery, since the reparative process in the healing of the muscle wound is attended with such cicatrization as of itself to threaten compression of the nerve. At least this is the conclusion to which I have been led from observations I have made at secondary operations.

I believe it entirely justifiable, too, in selected cases, and I refer to those of massive cicatrization in the arm, to transfer the nerve to a plane between the deep and superficial fascia; by this procedure the nerve is totally isolated from a field of connective tissue, which may inhibit the reparative process.

The great problem of peripheral nerve surgery is that involved in resection and the bridging of defects. The bringing into apposition of the divided segments with appropriate sutures is a

[1] British Journal of Surgery, 1918, No. 23, vol. xx.

matter of minor consideration, if one observes certain accepted principles of nerve suture; but in gunshot wounds, resection is a matter of necessity, and to such an extent usually that approximation cannot be effected without resort to one method or another of bridging the defect. These methods now to be reviewed include posture, nerve-stretching, nerve flaps, *suture à distance*, tubulization, lateral anastomosis, implantation-suture, nerve-stretching, transposition; some of these may, I think, be discarded, with a few words, because whatever evidence there may be from the experimental laboratory the clinical evidence does not justify their adoption as acceptable procedures.

The so-called flap-operation as proposed by Letievant is not deserving of consideration, since when the central and peripheral flaps are reflected the ends of the respective flaps would not be in alignment, and this would interfere with the downgrowths of neuraxes. The modification of this flap-operation, in which a flap is taken from a healthy nerve, is objectionable, chiefly because it involves sacrificing a portion of a normal nerve. The operation would be practicable only when two large trunks were in proximity, as in the upper arm. But one would hesitate in a case of ulnar paralysis when the disability will often not affect deleteriously the patient's earning capacity to sacrifice either the median or musculospiral.

As Huber says, *suture à distance* is more of academic than practical interest. In his laboratory experiments success was attained in two out of three instances by interposing bundles of coarse catgut between the divided ends, but I know of no successful attempts in human surgery.

Tubulization, as a means of bridging defects, has been used extensively both in the laboratory and the clinic, but there have been so many clinical failures that I have scrupulously avoided it. With Prussian pertinacity the Germans clung to this method in the early stages of the war. The so-called Edinger's tube, the formalized calf artery, was repeatedly employed, sometimes filled with blood serum, sometimes with agar-agar, but always, and I have seen the reports of 100 cases, with failure. Not only

was there no evidence of regeneration, but on later examination the gap had increased and bulbous formations were found on either end of the divided nerve.

In this connection a word may be said as to the use of protective sheaths both in neurolysis and nerve suture. I have refrained from any protection to the liberated or sutured nerve with fascia, fat, calf arteries or any other material, since there is every reason to believe that devitalized tissues, such as the foregoing, will stimulate connective-tissue formation and thus militate against, rather than facilitate, nerve regeneration at the line of suture. A pedicle flap of muscle, fascia or fat might overcome the objection to the use of these so-called protectives, but it has been my belief that the nerve sheath itself, if carefully approximated with sutures, offers adequate protection from the invasion of connective tissue.

Lateral anastomosis, as practised by Hofmeister[1] has no merit whatsoever. In his report, which contained the notes of twenty-four operations, the results of the operations were not included. It is merely assumed that a neighboring healthy nerve serves as a favorable and convenient medium for the downgrowth of neuraxes. If the terms lateral anastomosis and lateral implantation are synonymous, I quite agree with the wholesale condemnation this method has received. Tinel speaks of it as always useless and often mischievous; Moynihan, as to be sharply condemned, and Benisty as illogical.

In order to avoid confusion, we must, I think, coin another term for an operation, similar to lateral anastomosis, in that the central or peripheral stump alone or combined are sutured into an adjacent nerve, but differing in this essential respect, namely, that a portion of this adjacent nerve is sacrificed. This is virtually a nerve suture, and the term I would suggest as appropriate would be "implantation-suture."

I believe this operation has a field, limited though it may be, chiefly in the arm, with large defects in the ulnar or musculo-

[1] Beiträge zur klin. Chir., 1915, xcvi, 329.

spiral, not only because a healthy nerve is accessible, but because certain portions of the median may be sacrificed with only slight and transitory sensory loss. While on physiological and anatomical grounds I have regarded this so-called implantation-suture as justifiable in selected cases, I have not yet had a case in my clinic for which I thought it was appropriate. But looking over the literature I found several instances in which it had been practised with success. Thus in one of Joyce's cases, an ulnar lesion,[1] while almost one-third of the circumference of the median nerve had been sacrificed, the sensory loss was entirely recovered in course of time and in twenty-four months there was partial sensory and motor recovery in the ulnar area. Souttar[2] employed the method in two cases (Case 54 and Case 56); in one he implanted the lower segment of the musculospiral nerve, which was attached to the center of the front of the median, the fibers of which were divided. Ten months later there was faradic response in the extensors of the wrist. In the second case there was strong synergic action of the extensors of the wrist twelve months after the operation. It was noteworthy that Joyce cut the inner third of the median nerve and Souttar the external anterior fibers, and in both instances there was only transitory sensory disturbance.

On two occasions, one with a defect in two nerves and another with a defect in three, I have resected 5 cm. of the humerus. This is a radical procedure, and should be a court of last resort. When practised the operation should be divided into two stages, at the first liberating the nerves and resecting the humerus. This necessitates an incision on both the inner and outer aspects of the arm, and after connecting the neuromata of the several nerves with strands of silk for later identification the wounds are closed and the second stage is not undertaken until one is assured of uncomplicated wound repair. In one of the two cases, because of the time required at the first sitting in disentangling the injured nerves, the ulnar, median and internal cutaneous, the

[1] British Journal of Surgery, January, 1919, p. 426.
[2] Ibid., October, 1918.

bone was not resected until a second sitting and the nerve finally sutured at a third.

The susceptibility of nerve trunks to stretching offers a valuable auxiliary measure for dealing with defects. Weir Mitchell in his classical monograph called attention to the tolerance of nerves to forcible stretching, and we know that without the risk of rupturing its fibers, 2 to 4 cm. of a defect may readily be made up. Nerve-stretching with posture will often suffice to secure apposition in a defect of 7 to 8 cm. There are two ways of stretching the nerve, one as just described in the course of the operation, the other over a more extended period. The latter will be called for only in exceptional instances, and I do it in this way. If, after the nerve is liberated, it is evident that the defect cannot be bridged except with a graft, I pass heavy silk sutures through the bulbs and draw them as closely together as possible with the forearm or leg flexed. During the succeeding four weeks the limb is gradually brought into a position of extension and by this process the nerve stretched. At a second operation, by bringing the limb again into flexion, approximation of the segments after resection is possible. This technic is particularly serviceable for injuries of the arm when two or more nerves are involved.

Nerve transposition as an aid to bridging defects is most helpful and is applicable to the ulnar and musculospiral, the former more frequently than the latter. The course of the musculospiral I have shortened by passing the peripheral segment between the biceps and brachialis anticus and uniting it with the central segment on the inner aspect of the arm. The ulnar is isolated from its normal location and transposed to the flexor aspect of the forearm. I can see no advantage in following Stiles's recommendation to tunnel beneath the pronator radii teres, and there are many disadvantages. In the first place the deeper course is the longer when the forearm is in flexion, as it usually is when the nerve is sutured, and, secondly, the branches to the flexor carpi ulnaris and flexor profundus digitorum are sacrificed. These rami may both be conserved, providing one slits them up as far as may be necessary beyond the point at which they join the

parent trunk. Even though it may be more important to restore function to the intrinsic muscles of the hand, it need not be done at the expense of the ulnar flexor supply. The third situation in which transposition may be of service is the knee. Here in large defects of the external popliteal the distance from the bifurcation of the sciatic to the head of the fibula may be shortened by transposing the nerve to the external surface of the hamstring tendon with the limb in flexion.

With large defects, advantage must unquestionably be taken of favorable positions to secure apposition without tension, such as flexion of the forearm or knee and adduction of the arm, inclination of the head toward the affected side.

As a last resort only should one introduce a transplant, not that there is not enough clinical evidence at hand to warrant the procedure, but the percentage of successful sutures is greater with direct suture than with the graft. In dealing with 150 nerve lesions at General Hospital No. 11 we have used a graft to repair the defect on seven occasions as follows:

1 musculospiral	defect 7 cm.		Transplant; musculocutaneous (leg)
1 brachial plexus	defect 7 cm.		Transplant; musculocutaneous (leg)
1 ulnar . . .	defect 5 cm.	(*a*)	Transplant; musculocutaneous (leg)
		(*b*)	Transplant; dorsal branch of ulnar
1 ulnar . . .	defect 14 cm.		Transplant; musculocutaneous (leg)
1 external popliteal	defect 8 cm.		Transplant; musculocutaneous (leg)
1 median . . .	defect 8 cm.		Transplant; musculocutaneous (leg)
1 brachial plexus .	defect 5 cm.		Transplant; musculocutaneous (leg)

It is too soon to report ultimate results, but in two of the seven there is already evidence of regeneration. In a brachial plexus lesion the fifth cervical nerve was replaced with a transplant of 7 cm. from the musculocutaneous of the leg, and already there is a faradic response in the deltoid muscle. In a second case, a 5 cm. defect from the level of the wrist and upward, there is tingling on pressure over the graft 3 cm. below the upper line of suture. In every instance an autograft has been used, and usually the musculocutaneous, although according to one's convenience, the sural, the radial or with a defect in the nerves above the elbow

there is no reason why the internal cutaneous should not be used. Two to four cables, according to the size of the nerve, should be used and the sutures should be introduced in either end of the transplant at the proper interval before it is severed from its connection. According to Huber, whose investigations during the past two years have been most illuminating, the fascial cuff should not be used and we have observed this injunction. Huber believes the autotransplant should always be given preference, but in a recent communication he writes that he has obtained favorable results with homotransplants stored in vaselin and in liquid petrolatum. In his experiments with homotransplants, stored in 50 per cent. alcohol, the neuraxes have grown 3 cm. into the distal segment.

In reckoning how much of the nerve is to be resected, as many fasciculi as possible should be spared. By palpation, inspection and with the clinical notes one can determine whether the entire trunk or but a part need be sacrificed; but when in doubt electrical excitation is helpful, stimulating first the various aspects of the nerve through the sheath, and if still in doubt, after the sheath has been opened. By this means I have been able to conserve healthy fasciculi which otherwise would have been sacrificed.

For the ultimate success of suture, healthy fasciculi, free from the grasp of cicatricial tissue, is, in the final analysis, the most essential factor. Granted these, the prognosis may be good in spite of a clumsy suture. One is always tempted to keep the defect to within reasonable limits, fearing the difficulty in securing apposition. But if after the preliminary sections, distal and central, the cut section does not present healthy fasciculi without scar tissue, slice after slice should be removed until the desired picture is obtained. One soon learns to recognize these conditions; when, upon section, the ends of the fasciculi project a little beyond the cut surface, one is reasonably sure that the section has been made above and below the invasion of scar tissue. Per contra, if the cut section is smooth and the fasciculi do not project it is because they are engaged in scar tissue and a

higher or lower level must be inspected. Successive sections should not be made at greater intervals than 2.5 mm., since at this distance the whole picture may change. I have found a safety-razor blade preferable to either a scalpel or ordinary razor blade. The sheath of the nerve must be grasped on either side to steady the nerve while the section is being made.

One tension suture of chromic catgut, through the entire thickness of the nerve, $\frac{1}{2}$ to 1 cm. from the free end, according to the thickness of the nerve, with four to eight perineural sutures of the finest silk, suffices to keep the sheath in apposition. The tension suture should not be tied until the perineural sutures are in place, and then just fast enough to bring the fasciculi in contact; if too tight, the fasciculi will be crushed; if too loose, a blood clot may form in the interspace. Second in importance only to the necessity of securing a healthy segment for suture is the avoidance of undue tension. Every resource must be availed of to enable one to bring the segments into apposition without undue tension.

We have dealt in but fragmentary fashion with the problems of nerve-reconstruction. There are many minor points in technic as affecting individual nerves that are deserving of consideration. Enough has been said, however, to emphasize the complexity of the problem and the important part played by judgment and experience. Nothing has been said of tendon-transplantation for those cases in which nerve suture has failed or is difficult or where spontaneous regeneration has been arrested. The two situations in which tendon transplantation is particularly adaptable are (1) in the residual paralysis of the extensor longus digitorum, when the patient has recovered full power in all the muscles supplied by the musculospiral, with the exception of the common extensors to the fingers; and (2) in the residual paralysis of the anterior tibial with foot-drop. Tendon transplantation should be resorted to in both these lesions, and no patient should be discharged until an attempt has been made in this way to supplement the paralyzed muscle.

The after-treatment is a matter of vital consideration; mas-

sage, galvanism and later faradism, properly selected exercises, these must be continued faithfully and persistently until voluntary movement has returned. Secondary operations in some instances will be inevitable.

The Surgeon-General has given every consideration to this branch of reconstructive surgery. Within two months practically all cases requiring surgical treatment will have been operated upon. Recovery of function is a slow process and it remains to be determined how long after the operation the patients will be retained in government hospitals.

The final chapter on peripheral nerve surgery cannot be written until two years hence, at least so far as concerns the wounded of the American Forces. The final test of superiority claimed for one method or another must be based upon the end-results. As one of the most important functions, it remains for the Peripheral Nerve Commission, acting under the direction of the Surgeon-General, to follow up all cases that have or will be discharged from the general hospitals and prepare a final report based upon the end-results.

DISCUSSION

Dr. Richard H. Harte, Philadelphia:

It would be a great pity to allow such a valuable paper as Dr. Frazier has just read to pass without comment. Dr. Frazier has had a very large experience in this line of work, and I know from personal observations the results that he is obtaining. He is, I think, throwing a great deal of light on nerve surgery, which for a long time has been enveloped in darkness. Several cases returning from the other side I have had occasion to refer to Dr. Frazier, taking them away, as it were, from the hands of less experienced operators who were very keen to operate; in one instance even before the wound was healed. Dr. Frazier has emphasized the importance of allowing these cases to wait, and he has very properly increased the period that they shall remain unoperated after the wounds have healed. Tuffier brought out that point very noticeably three years ago in Paris. In one case, operating shortly after the wound had healed, he lighted up an old focus of infection, and, as a result, he had a condition which apparently was there from the beginning, but encapsulated. Now, there will be many of these cases scattered throughout the country, and many of the patients will not be satisfied with results that Nature has given them and will demand some operation. It is rather curious to note the demand that is made upon the family physician by some who have received nerve injury. They believe surgery is a remedy for all conditions and cannot understand why the functions of a palsied hand or an impaired lower extremity cannot be thus restored. Dr. Frazier has emphasized the importance of leaving many of these cases alone. I have seen a number operated on which I think would have been better left untouched unless operated on by a man of large experience. As I have said, we owe to Dr. Frazier a sincere vote of thanks for the time and care he has been exerting in this rather non-spectacular type of surgery, in which the results often are not very brilliant.

Dr. Frazier (in closing):

In answer to the inquiry regarding the technic of nerve suture, I may describe it briefly as follows: One stay suture of chromic catgut and four or more epineural sutures of the finest silk are used to effect apposition of the segments. The stay suture is of advantage in preventing the leakage of blood between the two nerve segments and the ultimate organization of a blood clot, which would serve as a barrier to the regeneration of neuraxes. As a minor detail in technic,

but one of very great convenience, I would suggest that the stay suture be not tied until the epineural sutures are all in place and tied. Meanwhile the slack in the stay suture is taken up, so that the nerve segments are in contact, and are held in that position by clamping the stay suture in either segment with rubber guarded hemostats. If the stay suture is tied before the epineural suture in a nerve under tension, the fasciculi will bulge out beyond the periphery, and it will be difficult to tuck them in and cover them with sheath, as the epineural sutures are tied.

I was glad to hear Dr. Harte speak approvingly of the conservative attitude we had maintained toward the "time of election" for operation. When I use the word "conservative," I do so only in comparing the practice of the peripheral nerve center, in which I was stationed, with that of other centers in the country. I believe the "three months' rule" is a sound one and will lower the incidence of infection. In something over one hundred operations we had only three or four infections, two of them quite superficial. This seemed to me, taking all factors into consideration, a fairly satisfactory record, and I was somewhat chagrined to receive a semi-official rebuke, because we had had infections in "presumably" clean cases. Considering, however, the fact that in many instances it cannot be "presumed" that the cases are clean, that the field of operation is a mass of scar tissue, poorly nourished, that the operations involve tedious dissections of three or more hours, our percentage of infections should not have provoked criticism. As a matter of fact, given one hundred cases of healed wounds in the arm, there would be as many cases of recrudescence of infection without operation as there were so-called accidental infections in our operative series. It is, I am sure, a matter of regret, to you as to me, that one of our Fellows, Col. Hutchinson, could not be here, both to take part in the discussion and to present to the Association the results of his personal experience with nerve suture at Neuilly. His end-results were exceptionally good.

SALVAGE OF THE HAND BY TIMELY REPARATIVE SURGERY

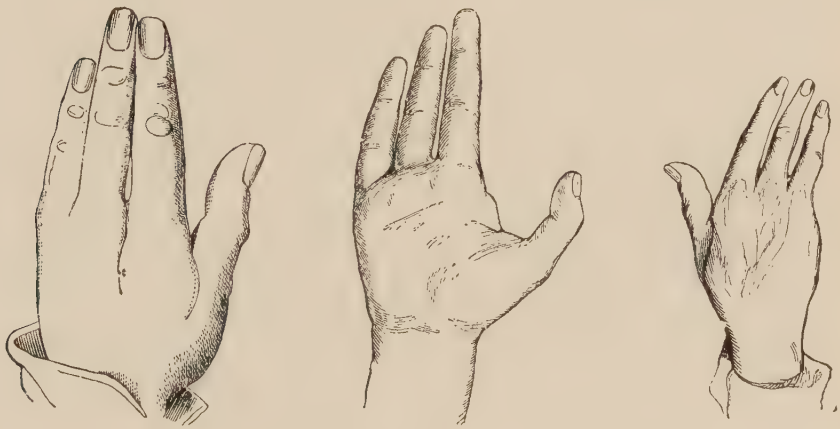
By JOHN B. ROBERTS, M.D.
PHILADELPHIA

The human hand has often in the past been denied the benefits of wise early treatment and the help of the reconstructive surgery now so effectively applied to other regions. This surgical neglect has arisen from two chief causes. Many patients with injuries of the structures concerned in finger movements are sent for treatment to hospitals, in which such hurts meet only the eyes of a tyro in surgery. This surgical interne realizes that walking patients are not of great interest to the experienced surgeon, that the damaged hand will probably not be given treatment in the hospital wards, nor if admitted to the ward will they be kept in bed. Hence he considers himself justified in assuming full care of the injury. Foot wounds are much more likely to be seen by a surgical chief and be well treated than are manual mutilations. An exception to this statement is justified when these hurts occur in manufacturing plants having a well organized surgical service with a wide-awake and well paid up-to-date surgical head.

A second cause of inefficient management of crippling wounds of the wrist and hand is delay on the part of even skillful operators to give attention to new developments in surgical art. They think they "know it all." On the other hand, men who admittedly have had but moderate surgical experience and who are therefore of unripe judgment show an unwillingness to serve as dispensary, or out-patient surgeons. Their chief desire is to rush into what may be termed capital or major surgery. They

need to be taught by their official medical superiors that the out-patient service gives opportunity for surgical practice of the highest professional quality if combined with earnest and thoughtful intelligence, careful records, accurate treatment and a systematic search for end-results.

One need only think of the innumerable misshaped and crippled hands and forearms due to unreduced and badly treated fractures of the lower end of the radius to appreciate the truthfulness of my statements. The unfortunate deformities not infrequently seen in men who have been treated, by the average surgeon, for



FIGS. 1, 2 and 3.—Results of amputation above metacarpo-phalangeal articulation in middle, index and ring fingers. (Erichsen.)

fractures of the mandible, are corroborative evidence of a similar lack of professional acumen in another field of reconstructive surgery.

The professional services rendered in accident wards and dispensaries to ambulant patients entrusted to unfit doctors have long been criticized by those who are familiar with existing conditions. It has been as difficult to get the medical and administrative officers of such hospitals to wake up to this evil as it was formerly to convince them that anesthesia perils to the lives of confiding patients were a disgrace. At the present time, not a

few hospitals need a change in their methods of handling so-called minor surgical lesions of the hand and finger. It is not my intention on this occasion, to dwell upon the measures by means of which the care of such hand wounds may be improved; nor do I wish to detail the therapeutic indications, the operative procedures, or the mechanical aids now offered by surgery for prevention or relief of special manual disablements.

FIG. 4.—Fixation of thumb in extreme extension after necrotic burns of forearm and hand. Illustration made from a crude photograph out of focus. Compare Fig. 5.

It, however, is my hope to arouse in the minds of us who are surgeons and those who manage hospitals a recognition of the necessity for a united voice demanding that men who are hurt shall not be deprived of industrial usefulness by reason of professional ignorance or indifferent surgical care.

Let me, even at the risk of making my paper seem like a catalogue, bring to your minds some well-known conditions liable to meet with inefficient management, when entrusted to busy or uninformed or careless surgical practitioners.

Think of the lack of instruction on intelligent asepsis in many

first aid dressing rooms; attempt to estimate the degree of unnecessary suffering from infected fluids under tension; remember the delay in giving pus exit because of insufficient incisions, or continued plugging with dry dressings, or with ridiculous corks of supposed drainage material; watch the spreading lymphangitis and the occurrence of distant lymphadenitis because motion of forearm and hand has not been prevented by proper splints; observe the rise in bodily temperature due to

FIG. 5.—Showing relief of hyperextension of thumb after burns of forearm and palm. Hand needs further reconstruction, though the change in angle of thumb by previous operations has been about 180 per cent. Compare Fig. 4.

confined septic exudates and the gradual sloughing of edges of sutured lacerated tissues which should have been cut away or left unstitched until closure was reasonably permissible; remember the damage possible to happen to tendons, nerves and joints from incisions for treating paronychia at the hands of unskilled operators; calculate, if you can, the value of digital deftness lost by a half dozen badly treated palmar abscesses; think of the number of unnecessary amputations of fingers and portions of hands which may take place in any large metropolitan hospital in one year.

Some of these surgical misdemeanors result from limited clinical experience; others are due to an overdevelopment of operative

FIGS. 6 and 7.—Extension of fingers, enabling patient to play piano, and full flexion in making a fist. This result was due to plastic reconstruction of deformed hand in youth to relieve hyperextension of fourth and fifth fingers, caused by burn on back of wrist and hand.

zeal. To be a surgeon is supposed by not a few beginners in our art to entail necessarily the abundant shedding of blood. This

defective definition may urge a too hasty resort to the scalpel. There are, however, instances also of deficient examination of patients to which the blame may be attached. Crippled hands, too, may be the result of aseptic closure of wounds at or above the wrist being done without the operator seeing that tendon suture or even nerve suture or stitching of divided muscular bellies may be demanded by the severity of the injury.

Crushing and extensively lacerated wounds from machinery, destruction of soft parts by burning, and damage arising from

FIG. 8.—Tunnel flap for subcutaneous transfer of tissue of thigh to repair thumb. (Keen's Surgery, after Haubold.)

gunshot fractures are especially liable to unwise surgical treatment. The determination of what should be deemed non-viable and at once removed is not always easy. Inexperience in averting infection of contaminated wounds may induce unnecessary operative mutilation. So also unfamiliarity with recent developments of plastic reconstruction with pediculated flaps, bridge flaps, transplants of skin, bone and tendon may influence the selection of primary amputation, when delay would give opportunity for successful secondary patching of palm or dorsum,

readjustment of bony fragments, transfer of muscular attachments and perhaps even arthroplasty.

It is very probable that many surgeons do not yet sufficiently recognize the invaluable assistance obtainable through baking, hot water soaking, and efficiently regulated massage in rigidity of fingers from inflammatory exudates and the fibrous transformation of granulation tissue. Cavities and gaps to be repaired, after gangrene, should seldom be permitted to close up by means of the slow fibrous contraction of granulations. It is usually

FIG. 9.—Lacerated thumb after subcutaneous transfer of integument. Ultimate result about five months after original operation. Compare previous figure. (Keen, after Haubold.)

wiser to promptly obtain a sterile, or relatively sterile, surface, and substitute for the missing structures a transplant or flap of integument, adipose tissue, fascia, bone or nerve. Much deformity may be due to long waiting for healing through fibrous transformation in secondary repairs. The contractile power of fibroid change in granulation tissue of wounds has been shown by Carrel and other experimenters to occur to a degree almost beyond belief. Fibrous tissue healing of deep wounds or after extensive loss of substance in the hand may be a wary and

unrecognized enemy of the surgeon. Finger joints become locked in disabling ankylosis or are by a slowly increasing change in axis caused to undergo secondary dislocation. These distortions are sometimes so slow in reaching their maximum that their possibility is not sufficiently anticipated by the surgeon. He may be startled months after a patient has been discharged from treatment by having a deformed hand presented to him for explanation in a suit for malpractice.

Burns of a necrotizing degree are particularly liable to produce these manual disabilities. I have operated with final success on a number of such cases in children. Using skin and subcutaneous fascia in pediculated flaps from forearm or neighboring parts of the hand, or supplying the needed tissue by stitching the hand to the abdomen from which a flap with pedicle has been lifted, have been very satisfactory. It is often necessary to do a series of operations. The scar tissue usually must be dissected away quite freely before the flap of normal tissue is sewed in the gap. The distortion should be relieved fully by the dissection before the flap is inserted. Aseptic operations and asepsis during the healing are of great value in hastening the restoration of function. Septic complications, although very undesirable, fortunately do not always bring complete failure. Each operative effort in the series may gain something. Massage, hot water bathing and baking carried out for weeks may complete an imperfectly obtained operative reconstruction. Free flaps, or grafts, seldom give results, however, unless the operation and after-treatment reach a degree of sterility that is almost perfect.

Much may be done to relieve the deformities due to anemic myositis, often called Volkmann's contracture, if the surgeon recognizes early the beginnings of this neuromyositic change occurring from undue pressure of bandage or splint upon the muscles and nerves of the arm. The appearance of trophic changes in the finger-nails and a slight spastic rigidity of a group of muscles should at once arouse suspicion of what is happening. Relief of pressure must be instantaneous; and massage, hot water soaking and splint or elastic traction be used to give aid to the

relatively weak muscles. Long continued treatment of this kind aided by electric stimulation, may avert and even correct grave

Fig. 10.—A Reconstruction Aide freeing a scar from the bone by massage. Weeks of patient endeavor are finally rewarded by motion and strength returning to the useless wrist and fingers. From P. H. Knight, in "Carry On," March, 1919.

manual disability of the fingers from fibroid alteration of the affected muscular bellies and fibroid changes in the joints. Old

cases may be improved by transfer or elongation of tendons, and other orthopedic devices; but I am speaking now of the advantages of an early and alert institution of what may be termed physiologic therapy.

Industrial and military injuries give many chances for saving damaged fingers by using plastic procedures. Hence, such wounds should not be entrusted to those uninitiated in reconstruction of soft tissues. Even the skeleton of the carpus, metacarpus and phalanges may be susceptible of osteoplastic reconstruction. A thumb with a movable little finger is better for a mechanic than the most beautiful artificial hand. So also is there greater efficiency possible from a mere stump of the thumb with such parts of the other fingers as will give the man a grasp. Excision of metacarpal bones may convert a badly shot or crushed hand into a member looking like a crab's claw, but even that gives a better wage-earning tool than an expensive imitation of the human hand.

Amputation of fingers merely stripped of integument has often occurred at the hands of would-be surgeons, although pedunculated flaps from abdomen or thigh would have furnished a new covering for the marvellously competent tendons left uninjured by the accident.

Tendon grafting, nerve grafting or nerve suture, transfer of muscular insertions, and carefully planned substitution of new bony segments to the skeleton of the hand come to mind as useful expedients to be ever kept in mind by surgical attendants upon industrial workers or soldiers who have received disabling wounds of the upper extremity. These expedients are applicable to old as well as recent injuries; but the golden opportunity is usually at the time of accident. It is possible to use a toe grafted on the hand as a substitute for a thumb.

Congenital deformities of forearm and hand are susceptible of great relief by plastic operations. Plastic flaps, skin grafting, bone grafting and similar procedures have been utilized in recent years to an extent which was unanticipated a few decades ago. Asepsis, anatomic knowledge and artistic reconstructive surgery form the tripod upon which successful work depends.

Surgeons should remember that mere amputation requires little operative skill. It may be an opprobrium of surgery. The question should be how much more valuable to the patient will

FIG. 11.—Solving a knotty problem. (From H. E. Mock, in "Carry On," April, 1919.

be an efficient semblance of a hand of bone, muscle and nerve than the most beautifully modeled mechanical substitute with little functional ability. He must not forget that spastic muscular

contraction or scar rigidity may cause an almost irremedial distortion or prevent the adjustment of an artificial hand. Early efforts of the patient to train the residual tissues left by the operator must be demanded. Such aid as exists in heat, massage and orthopedic expedients must be furnished the crippled man.

FIG. 12.—One-armed bracemaker's apprentice's method of gripping the hammer between the stump, upper arm and chest. (Leo Mayer.)

His mental attitude toward deformity must be modified by insistence that good looks are less valuable than good works. Sentimental timidity of the patient has no place in reconstructive surgery of the hand. He must be urged and driven to train his remaining fingers, his stump or his forearm and arm muscle to develop manual facility. The surgeon must not think his respon-

sibility ceases with healing of operative or preoperative wounds. Contraction in flexor muscles is more likely to occur than in the extensor group. This should be averted by active and passive mobility begun promptly. In amputation through the forearm and even in the arm, all joints and muscular masses possible

FIG. 13.—The Keller artificial hand. The picture illustrates Keller's method of inserting a small knife, with which he is sharpening his pencil. Note also the piece of cork attached to the pencil. This enables him to grip the pencil between the claws and to write with it. The lower arm socket is held firmly in place by a broad strap which makes a figure-of-eight turn about the elbow. (Leo Mayer.)

should be saved, because artificial hands can often be made valuable by using muscles in the stumps to pull on springs moving the mechanical fingers. The elbow-joint is a very necessary adjunct to an efficient artificial hand. A stump below that joint and even a muscular mass remaining below the shoulder-joint may be utilized to give motion to the prosthetic hand.

Instruction in moving the muscles left in a stump will often enable plastic secondary operations to give the patient a kinetic hand, otherwise impossible. Leo Mayer has well stated this fact. (*International Clinics,* 1918, vol. iv, p. 200.)

Sauerbruch, Ceci and Vanghetti have done valuable work in this direction. Fellows of this Association who have seen military

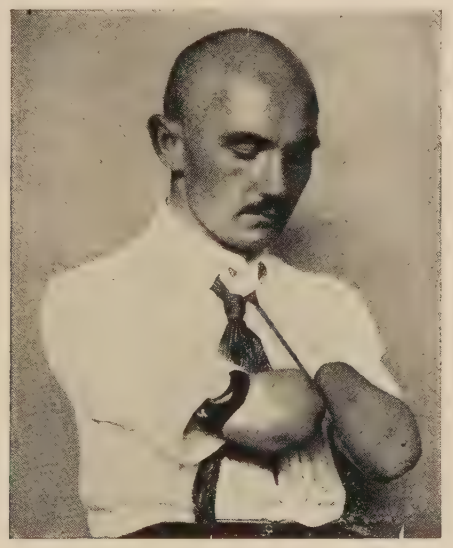


FIG. 14.—A teacher, both of whose hands had been amputated when six years old. He had learned to be absolutely independent and had passed his examination entitling him to a teacher's license. Without artificial limbs he could dress himself (the illustration shows him in the act of buttoning his collar), shave, eat with grace and assurance, write an unusually legible hand with more than normal rapidity, travel long distances alone, carry a suit case and pay his fares, just as the normal individual would. All this was done by careful education of the stump, which in his case had acquired almost the same sensitiveness as the tips of the fingers. (Leo Mayer.)

service can probably teach much in salvage and orthopedic development of injured hands. Modification of badly created stumps may be required. Wise selection of substitutes for the hand will often need expert advice from men with trained mechanical experience.

It will be admitted that few deformities congenital or acquired exceed in importance those which destroy conventional use of the hands. Total or partial inability to clothe or feed oneself or to minister to one's own necessities or amusements usually creates at first a state of mind and a poverty of happiness which must be remedied. Whether the disability be great or little, the

FIG. 15.—Judge Corley's apparatus for helping a man who has lost both hands to button his collar. (Leo Mayer.)

educational side of the compensatory training is not to be forgotten. The patient must be taught that even the loss of both hands does not create a helpless invalid; and that a partial loss only of one or both hands constitutes a very valuable asset in his after-history.

Prosthetic appliances are of very little value when first installed. Consideration of the mental equipment and the needs created by the deformity must be joined with a wise selection of an appliance which will permit requisite mobilization of the structures retained in the hand or those to be provided by a mechanical

substitute. Very simple appliances will permit a man to perform many kinds of manual work after amputation of the entire hand. P. H. Knight in the March number of *Carry On* shows pictures of a man who lost both hands by amputation through the forearms. By means of extensions of the forearms and attached wrist plates, to which hooks and other implements are fixed by means of a spring catch, he can dress himself in about a half hour, shave himself and even button his collar and tie his shoes. He writes, uses the telephone and for more than twelve years has earned "good living wages" in a manufacturing company. Such ability gained at the adult age after bilateral amputation of the hands rivals that which is seen in the use of toes instead of fingers in persons born without hands or arms.

A number of hands have been devised which have the appearance of the natural members. It is possible to secure mobility of wrist and fingers and rotation of the hands by some of these artificial hands. By using hooks, braces, springs, levers and the stumps of muscles, even if these muscles are far from the substitute for the hand, nearly all amputation cases can be helped. Some artificial hands obtain movement of fingers through levers which secure motion from muscular action near the elbow-joint or from the region near the shoulder. It may be necessary in some patients to make a shoulder or other joint rigid, or perhaps to create a false joint by arthroplasty. Constant training of the muscles and insistence upon the remedial character of the patient's deformity will in time develop a remarkable degree of manual ability.

A CASE IN WHICH FOR OVER THIRTY-FIVE YEARS A WOMAN DEFECATED AND URINATED, AND FOR ELEVEN YEARS MENSTRUATED BY THE RECTUM.

By WILLIAM W. KEEN, M.D.
PHILADELPHIA

A CASE in which for over thirty-five years a woman defecated and urinated, and for eleven years menstruated by the rectum is worthy of a final record as an evidence of the possibilities of surgery and especially of the conclusive evidence it affords that the rectum can be utilized as a common cloaca for the urine and the menstrual flow as well as for the feces for an indefinite period.

The condition necessitating this novel use of the rectum was a case of extensive and incurable vesico-vaginal and recto-vaginal fistulæ caused by sloughing as a complication of typhoid fever. Ultimately I entirely closed the vaginal outlet.

I first reported the case publicly in my Toner lecture delivered at the Smithsonian Institution in Washington on February 17, 1876. It appeared in print in March, 1877.

In February, 1876, she had been entirely cured for seven weeks. When the lecture was printed she had remained cured for fifteen months. At her death, May 24, 1911, she had been cured for thirty-five years and five months.

In *Surgery, Gynecology and Obstetrics*, 1917, xxv, 391, Reuben Peterson has assembled 38 other similar cases in addition to 2 of his own, making 41 in all.

When my Toner lecture was delivered, February 17, 1876,

only one similar case, by I. Baker Brown, had ever been published (*Trans. Obstet. Soc.*, London, 1864, v, 25). Of this I was ignorant. So far as I then knew I was the pioneer. I first learned of Baker Brown's case in January, 1919, when I found it in Peterson's paper.

In 1851, Maisonneuve had performed this operation for the first time, but it was not published until 1889. Rose had operated on 3 cases in 1872, 1883 and 1886, but they were published, 1 case in 1878, and the other two in 1903.

In 1898, in my "Surgical Complications and Sequels of Typhoid Fever," p. 80, I republished the case bringing the history up to the end of 1897. The present record carries it down fourteen years longer and up to the time of her death.

It is the only one of the 41 cases caused by typhoid fever. In 33 cases in which the cause of the condition was stated, 25 resulted from childbirth, and 4 from operations for cancer.

A brief abstract of the case as published in my Toner lecture in 1876 and in my book on the surgery of typhoid fever in 1898 and my later notes is as follows:

Mrs. M. D., aged thirty-five years, first came under my observation in St. Mary's Hospital, Philadelphia, in 1873. In 1872 she nursed her husband in a fatal attack of typhoid fever and then fell ill of the same disease. About the fourth week the labia minora sloughed away and both urine and feces escaped through the vagina. In October, 1872, she entered the hospital under the care of my colleague Doctor Grove. He tried three times unsuccessfully to close the fistulæ by plastic operations. When I succeeded to his service I also made three equally unsuccessful attempts. In December, 1875, being convinced of the impossibility of success, I proposed to her a, to me, wholly novel operation, viz., the absolute closure of the vagina, leaving the fistulæ wide open. This would compel the urine and the menstrual blood to be voided through the rectum. I explained the operation and its consequences to herself physically and as to marriage very frankly to her. She at once accepted my proposition.

The operation was a success except at the anterior end of the cicatrix, which held everywhere else but failed at the internal end of what was left of the urethra, the vesical end of which had sloughed away. Several minor but always unsuccessful operations were done here. Finally, on December 28, 1875, I excised this small remnant of the urethra. This was her twelfth operation and was entirely successful. She had urinated, menstruated and defecated with entire comfort for seven weeks when I delivered the Toner lecture and described her case in full, February 17, 1876.

She had been a nurse and for nearly four years had been unable to earn a living. She had been socially and professionally a pariah by reason of the disgusting atmosphere in which she lived and moved. This successful operation restored her to her social world and to her means of earning a living. She urinated once or twice at night and five or six times during the day. Menstruation ceased in 1887, over eleven years after the operation.

After the operation fistulæ in the cicatrix broke out in 1877, 1896 and 1904, *i. e.*, at intervals of two, nineteen and eight years respectively. Usually they caused only a little leakage and only when in the erect posture. Once the fistula healed spontaneously, once after a minor operation. The third occurred in 1904, as follows:

In 1904, another small fistula appeared. However, as she was so slightly inconvenienced and as the escaping urine caused no odor about her person she did not consult me for two years. In October, 1906, at my suggestion, she entered the Jefferson Hospital under the care of Dr. Francis T. Stewart and Dr. F. H. Maier. They laid open several small pockets containing urinary concretions. This entirely relieved her.

In December, 1888, thirteen years after the vaginal closure, she sought my help and stated that the escape of urine was intermittent. Digital examination by the rectum showed that the recto-vaginal fistula had so contracted that it would only admit the tip of the finger. It also showed that there was a

calculus in the vagina which acted like a ball valve and explained the intermittent urinary flow. By inserting a curved hemostatic forceps I easily crushed the calculus. This consisted of urinary salts deposited on a small mass of feces.

At the date of her death on May 24, 1911, at the age of seventy-three, she had remained dry and well, with the exception noted, for thirty-five years and five months after the closure of the vaginal outlet. During all this long period she urinated only once or twice at night and five or six times during the day. She was wholly satisfied with the result of her persistent optimism.

No ascending renal, vesical or uterine infection occurred at any time, nor did mucous membrane of the rectum at any time resent the constant presence of the urine or the periodical presence of the menstrual blood.

CONGENITAL ARTERIOVENOUS AND LYMPHATICO-VENOUS FISTULÆ: UNIQUE CLINICAL AND EXPERIMENTAL OBSERVATIONS

By WILLIAM STEWART HALSTED, M.D.
BALTIMORE, MARYLAND

A. Advance of a Proximal Arterial Dilatation Conformable to the Transposition, after Operation, of the Fistula.

Thanks to the assistance of highly competent secretaries I have abstracts of about 400 cases of arteriovenous fistula. These have been studied with special reference to occasional observations on the dilatation of the arteries. In 52 instances proximal dilatation of the arterial trunk has been noted. I am quite sure that in almost every instance in which the fistula had existed for two or more months, proximal dilatation of the artery would have been demonstrable if looked for.

Congenital arteriovenous fistula is rare, particularly so when unassociated with nevus. We have been able to find reports of only 2 cases without and 6 with nevus. Of the former neither was cured, unless we except the case of von Eiselsberg, in which an attempt to cure a fistula between the popliteal artery and vein was followed by gangrene, necessitating amputation of the thigh.

The following case, unique in several particulars, is reported to record the arterial changes observed at two operations, the second performed six and one-half years after the first. The patient, a girl, aged eleven years, was operated upon by the author November 15, 1911, for a congenital arteriovenous fistula below

the angle of the jaw on the right side. After the removal of a tumor-like mass of enormously dilated veins it was found that the fistula was between one of these and the external carotid artery near the bifurcation or ventricle of the common carotid.

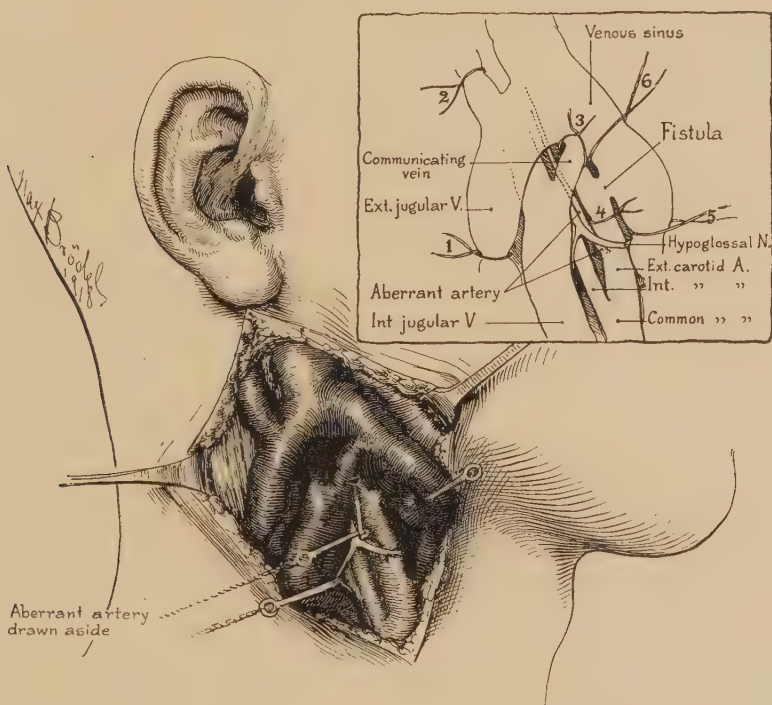


FIG. 1.—Congenital fistula between the external carotid artery and a large vein. Appearances at the first operation. Dilatation of the common and external carotid arteries central to the fistula and of the venous plexus. The internal carotid is abnormally small. There is a tiny, aberrant branch of the external carotid.

Fortunately a careful note was made at the operation of a very small anomalous, ascending branch given off from the external carotid just proximal to the fistula (see Fig. 1). There was great dilatation of the common carotid and of the external carotid arteries proximal to the fistula, whereas the internal

carotid was surprisingly small. The vessels concerned in the formation of the fistula were excised, the aberrant artery happily being spared. The child was relieved by the operation of very distressing symptoms, but a few weeks later signs of a second, smaller fistula developed at a distal point, just below and in front of the ear. A second operation, proposed frequently, was not acceded to until last spring, six and one-half years after the first. At this operation, performed by my assistant, Dr. Mont Reid, in my presence, remarkably interesting observations were made. The tiny aberrant artery had become dilated almost to the size of a goose-quill, and the internal carotid, which at the first operation was strikingly small, was, we estimated, as large as normal (see Fig. 2). The explanation of the findings is, I think, clear. There were originally two fistulæ. The chief of these being eliminated at the first operation, the second, distal to the first, functioned more and more freely in the course of the six and one-half years. The internal carotid, small at the first operation, being central to the main fistula, dilated after the subordinate or distal fistula became active; and the anomalous artery, also central to the main fistula, became dilated for the same reason. In regard to the development of the congenital arteriovenous fistula, Dr. Florence Sabin has kindly written me as follows:

"The anomaly of direct anastomoses between arteries and veins brings up an interesting point in the development of the vascular system—namely that vessels which have served as arteries in the embryo may become veins, and *vice versa*. One of the earliest examples of this occurs in the development of the vessels in the yolk sac of the chick. Primitively the anterior half of the yolk sac is entirely venous while the posterior half is entirely arterial, thus the omphalomesenteric veins and arteries are separated as far as possible by a wide capillary bed. Subsequently the omphalomesenteric arteries are accompanied by veins which develop as follows. As can be seen in *3*, Fig. 3, in Popoff's *Atlas*,[1] originally the omphalomesenteric arteries lie

[1] Popoff, D.: Die Dottersack-Gefässe, 1894. C. W. Kreidel's Verlag.

throughout their course in a capillary network. In the capillaries along the caudal border of the artery the blood flows away from

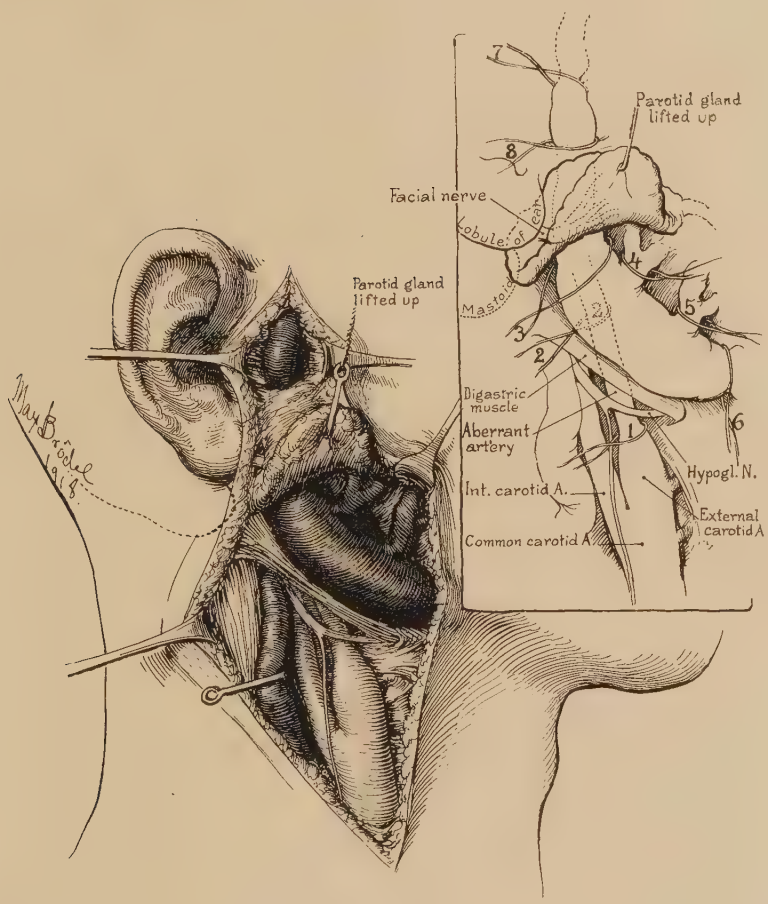


FIG. 2.—Appearances at the second operation. The internal carotid and the aberrant branch of the external carotid have become markedly enlarged up to the site of the second or peripheral fistula.

the heart while in those along its cephalic border it returns directly to the heart. As the chick develops these two sets of capillaries along the main stem of the artery lose their connections

with it and join each other, thus making a plexus which accompanies the artery and receives the blood which has passed out to the tip of the artery and returns it to the heart. In this plexus develops the vein which accompanies the artery. It is obvious that the retention of any of the original connections of these capillaries with the artery would form the basis of a direct anastomosis between an artery and a vein.

"In connection with the development of the veins of the head and neck, it has been shown that the internal jugular vein develops in three different segments. At first the blood of the cerebral veins, which make the first segment, passes through a long vein which rests on the hind-brain and ultimately becomes a plexus of vessels in the pia mater. From this deep vein the blood passes into the third segment, which is the anterior cardinal vein and thence through the duct of Cuvier to the heart. This deep vein along the hind-brain is then eliminated from the drainage of the cerebral veins by the development of a chain of capillaries between the aorta on the one hand and the cerebral veins and the anterior cardinal vein on the other. This chain of capillaries rapidly enlarges into the middle segment of the internal jugular vein. The original connections with the aorta are shown injected in *1*, Fig. 1, Sabin (1917),[1] for a pig embryo with 23 somites, measuring 7 mm. Moreover, injections of pig embryos measuring 14 or 15 mm. may still show slender connections between this middle segment of the internal jugular vein and the internal carotid artery.

"From these examples it is obvious that the details of the origin of each vessel should be worked out as a basis for specific anomalies that may occur in them, as has not yet been done for the external jugular vein, but the underlying principle that arteries and veins develop out of a common capillary plexus forms the basis for the persistence of direct connections between them."

[1] Sabin, F. R.: Origin and Development of the Primitive Vessels of the Chick and of the Pig, Contributions to Embryology, No. 18, Publication 226 of the Carnegie Institution of Washington, 1917.

B. Enlargement of the Heart in Cases of Arteriovenous Fistula and Persistent Ductus Arteriosus.

A particularly interesting result of our clinical and experimental studies of arteriovenous fistula is the discovery that enlargement of the heart probably occurs, after a time, as a rule, in the major cases. For ten years or more we have noted the condition of the heart in our patients with arteriovenous fistula, and have, I believe, almost invariably found it enlarged—strikingly so in several instances. Dr. Mont Reid, of our surgical staff, has in preparation a report upon his experimental and clinical work on arteriovenous fistula in which he will offer convincing proof of our view that the fistula in its consequences may profoundly affect the heart as well as the veins and arteries. Skiagraphs show the effects of a fistula made three and one-half years ago by Dr. Reid between the carotid artery and external jugular vein of a dog. The veins of the neck on both sides are dilated and the carotid artery is dilated central to the fistula. The heart after two years shows slight enlargement, and after three years it has become pronouncedly increased in size. If the assumption is correct that the heart dilates in consequence of arteriovenous fistula it is important that the fact should be brought to the attention not only of surgeons but also of pathologists and internists who apparently have overlooked it.

Our experimental and clinical observations on arteriovenous fistula and partial occlusion of large arteries may ultimately aid in the explanation of the sequelæ of certain congenital anomalies of the heart and aorta. May we not regard the persistent ductus arteriosus as an arteriovenous fistula, the pulmonary artery and the right heart representing the venous side of the fistula? The enlargement of the left heart we might assume for the moment to be somewhat analogous to the dilatation of the artery proximal to the fistula, and in the dilatation of the right heart and pulmonary artery we recall the dilatation of the veins.

My studies on the subject of the dilatation of an artery which we find occurs distal to a constricting metal band and distal to the compression exercised by a cervical rib have led me to

investigate the results of the congenital coarctations of the aorta at or beyond its isthmus. I have been interested to find that in a large percentage of these cases of coarcted aorta there is dilatation beyond the site of the coarctation. The generally

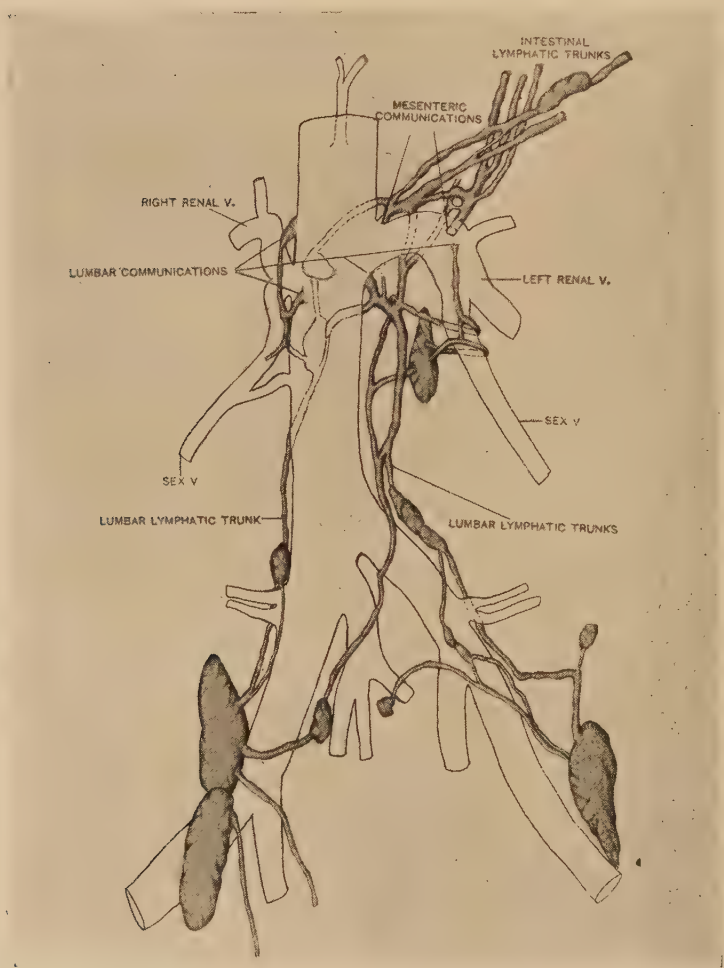


FIG. 3.—Cebus hypoleucus, Humb. White-throated capuchin.

accepted view that this dilatation is to enable the aorta better to carry on the anastomotic circulation must, it seems to me, be erroneous. When we shall have ascertained more precisely the cause of the arterial dilatation obtained experimentally below

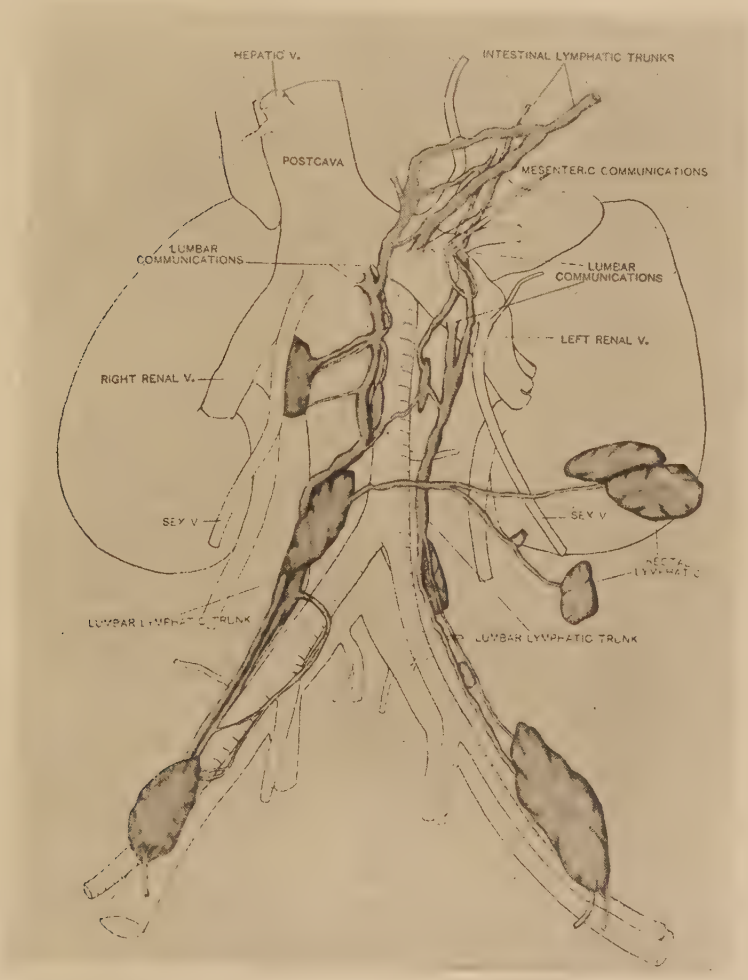


FIG. 4.—Ateles variegatus, Wagner. Variegated spider monkey.

constricting bands and of the dilatation of the artery proximal to an arteriovenous fistula we may be able to explain the dilatation of the aorta beyond the congenital coarctation.

C. Plausible Explanation of the Presence of Blood in Lymph Cysts at the Second and Subsequent Tappings.

A few years ago, assisted by Dr. Heuer, I removed from the abdomen of a woman, about forty years of age, a huge congenital hygroma or lymph cyst. The diaphragm was pushed high up into the right thorax and the liver was displaced far to the right, and so rotated on its vertical axis that its inferior border instead of being transverse was parallel to and almost in line with the linea alba. The enucleation of the greater part of the cyst was easily accomplished, a few adhesions being disposed of by gentle, blunt dissection. Finally, when there remained only a few filamentous fibers binding the sac to the right adrenal gland[1] and the inferior vena cava we proceeded with even more deliberation and caution. The adhesions to the vein were so delicate that the gentlest manipulation with the handle of the scalpel sufficed to break them. We had an unusually free and clear exposure of the vein and were operating without embarrassment. Suddenly blood gushed from a linear defect about 3 mm. long in the vena cava. The hemorrhage was promptly controlled and the slit in the vessel sutured. Proceeding thereafter with perhaps even greater delicacy we were again confronted with a gush of blood from the vena cava at a higher point. Here we found a slit about 1.5 cm. long in this vein. The edges of the slit were smooth, the linear defect being clearly not due to a tear or cut. The gap in the vein was closed by suture. Dr. Heuer and I satisfactorily assured ourselves that there was no defect or special thinning of the wall of the cyst at

[1] The relation of the cyst to the right adrenal gland was remarkable. In the course of stripping the sac's final delicate attachments we exposed a flat, black surface, evidently the spread-out medulla of the adrenal, about the size of a half-dollar; parenchymatous oozing from this surface required for its arrest a few mattress sutures of fine silk.

the point contraposed to the larger of the two defects in the wall of the vena cava.[1]

The defects or slits were surely not artefacts. They represented, I believe, imperfectly closed embryonic communications between the vein and lymph buds or lymphatic vessels. Dr. Florence Sabin, to whom we owe so much for our knowledge of the origin and development of the lymphatic system, writes me in regard to this case as follows: "Recent work on the lymphatic system serves to demonstrate that lymphatic vessels are modified veins. It has been shown that lymphatic vessels occur first in the neck as sacs lined with endothelium and packed with blood, which lie close to the jugular veins. The abdominal lymphatics begin as sacs which lie close to that part of the inferior vena cava which connects the two Wolffian bodies. Baetjer[2] showed in 1908 that in the pig this sac, which is the forerunner of the retroperitoneal lymphatics, communicates for a time with the inferior vena cava. These communications between the lymphatics and the abdominal veins, which are transitory in the pig, were then shown to be permanent in the South American monkeys by Silvester in 1912,[3] while in 1915 Job[4] demonstrated similar permanent connections in rodents. Thus the study of the development of the lymphatic system affords an explanation of anomalies involving connections between the lymphatic vessels and both the renal veins and the inferior vena cava.[5]"

The statement has repeatedly been made that hygromata

[1] The patient recovered promptly and has enjoyed excellent health since the operation.

[2] On the Origin of the Mesenteric Sac and the Thoracic Duct in the Embryo Pig, Am. Jour. Anat., 1908, vol. viii.

[3] Silvester, C. F.: On the Presence of Permanent Communications between the Lymphatic and Venous Systems at the Level of the Renal Veins in Adult South American Monkeys, Am. Jour. Anat., 1912, vol. xii.

[4] The Adult Anatomy of the Lymphatic System in the Common Rat, Anat. Record, 1915, vol. ix.

[5] Sabin, F. R.: The Origin and Development of the Lymphatic System, Johns Hopkins Hosp. Rep., Monographs, new series, 1913, No. 5. The Method of Growth of the Lymphatic System, The Harvey Lectures, Series XI, Philadelphia, J. B. Lippincott Company, 1915–1916.

which at the first tapping have yielded a clear fluid may be found at all subsequent tappings to contain more or less blood. Only one explanation has been offered for the presence of the blood, namely, trauma of the wall of the cyst. This explanation has always seemed to me an unsatisfactory one because the walls of these cysts are, as a rule, very thin and non-vascular. May it not, in view of the findings in our case, be possible that vestigia of lymphaticovenous communications (see Figs. 3 and 4[1]) are responsible for the admixture of blood which has occasionally been noted at only the second and subsequent tappings of lymph cysts and is more frequently found at the first tapping? The negative pressure consequent upon the aspiration of fluid from the cyst might divert for the moment a little blood from the vein which had given origin to the hygroma's lymphatic bud or vessel. Thus the contents of the sac, clear at the first withdrawal, would be bloodstained at the second. Thereafter, with each tapping blood would be aspirated into the sac and hence clear fluid might never again be obtained.

[1] Reproduced from Charles F. Silvester's paper (l. c.), with the kind permission of the author and the editors of the American Journal of Anatomy.

FURTHER OBSERVATIONS ON THE CONSERVATIVE TREATMENT OF SARCOMA OF THE LONG BONES

By WILLIAM B. COLEY, M.D.
NEW YORK

The present paper consists chiefly of a report of the cases of sarcoma of the long bones that have come under my personal observation during the past five years, with a brief review of cases previously published.

In a previous paper on this subject I have strongly advocated the conservative treatment of sarcoma of the long bones, and the cases observed during the past years, I believe, furnish further evidence in justification of conservative treatment. It might seem unnecessary to present this evidence, were it not for the fact that the majority of surgeons at the present time, including many men with wide surgical experience, have not fully accepted the principles of conservative treatment, and are now sacrificing many limbs which might be saved under conservative treatment.

In a paper read before the Southern Surgical Association in December, 1917, I published 200 cases of sarcoma of the long bones personally observed. Since that time 50 cases have come under my observation.

In the former papers I have discussed at considerable length the question of diagnosis. In the present paper I only wish to emphasize certain points which, larger experience has convinced me, deserve special note.

First, the element of pain. Pain, especially of a deep boring character, steadily increasing in severity, is often one of the earliest and most important signs of sarcoma of the long bones. Many of these patients are first treated for some rheumatic condition, until the disease has progressed sufficiently to produce a palpable tumor. Persistent pain is often present for weeks or months before there is a palpable tumor or the *x*-ray discloses any evidence of a new growth.

Pain is a more important symptom in periosteal growth than in the central tumors. The latter often attain considerable size, with little or no pain. I recently had under observation a case of periosteal sarcoma of the upper portion of the femur, in which severe pain was not only the earliest symptom, but required quite large doses of morphin before a swelling could be detected. Later on, a slight swelling was noticed in the outer aspect of the left femur, just over the trochanter. The *x*-ray at this time showed a slight thickening of the periosteum which, in conjunction with the clinical symptoms, made the diagnosis of periosteal sarcoma probable. Under the toxin treatment alone, the pain ceased almost immediately; later a local application of massive doses of radium was made. Four weeks later the pain returned and increased in severity. An exploratory operation was done, showing an extension of the disease downward and marked involvement of the periosteum, of the extent of which the *x*-ray examination had given little evidence. The tumor apparently started in the underlayers of the periosteal covering of the bone, causing some roughening of the bone and great tension of the periosteum, which easily explained the agonizing character of the pain, since a condition was present not unlike a subperiosteal abscess, which produces such excruciating pain. The periosteal tumor in some places began to infiltrate the overlying muscle and fascia. A considerable portion of this tissue was removed; macroscopically it was perfectly characteristic of sarcoma. In fact, with the clinical history and macroscopical appearance, one could easily make a positive diagnosis of sarcoma. In spite of this the tissue removed

for microscopic diagnosis did not show any characteristic tumor tissue, so that Doctor Ewing stated that he could not make a diagnosis of sarcoma. If the patient had continued to improve and made a complete recovery, there would always have been some doubt as to the diagnosis. A few weeks later another exploratory operation was performed in order to facilitate the use of bare tubes of radium. This time some of the tumor tissue was removed and examined microscopically. The histological structure was that of a typical small round-celled sarcoma. In very far advanced cases, the clinical signs, combined with the *x*-ray picture, may be sufficiently clear to definitely establish the diagnosis, and too much weight should not be given to a negative pathological report upon a specimen removed.

I still believe that in cases in which there is any reasonable doubt of the diagnosis, the advantages of an exploratory operation greatly outweigh the disadvantages. If the tumor is a periosteal sarcoma, it is extremely important to make the earliest possible diagnosis. It would certainly be unwise to sacrifice the limb, without a positive diagnosis, and it would be equally unwise to subject the patient to the discomforts of prolonged toxin or radium treatment, unless the diagnosis was reasonably certain. In the great majority of cases the clinical signs, confirmed by *x*-ray pictures, render the diagnosis practically certain. If the disease is far advanced, there will be no doubt. Even in these cases, particularly in tumors of central origin, it may be wise to make an exploratory incision, remove as much as possible of the tumor tissue, and, in the central tumors, curetting to bare bone in order to facilitate the use of conservative methods, particularly the introduction of bare tubes of radium into the cavity. The histological type of tumor found may give us great help in making a prognosis.

The danger of metastases resulting from such exploratory operations is, I believe, extremely slight, and the advantage of knowing exactly the type of tumor one is dealing with, far outweighs the risk.

Giant-celled Sarcoma or "Giant-celled Tumors." Great confusion has long existed in regard to the malignancy of the so-called giant-celled sarcoma of the long bones. Within the last few years several admirable papers have been published throwing much light upon this difficult subject, the most important of which are the contributions of Platou, of Christiania (*Annals of Surgery*, March, 1918), and Bloodgood (*Annals of Surgery*, April, 1919). Bloodgood reports 47 cases of benign giant-celled tumors (43 of the long bones) in which the ordinary features of malignancy were absent. A study of these cases has induced Doctor Bloodgood to make a repeated and even stronger plea than hitherto in favor of conservative treatment of these conditions.

My own experience, based upon a study of 250 cases of sarcomas of the long bones, would justify me in going even further than Bloodgood, and I would urge the employment of conservative methods not only to benign giant-celled tumors, osteitis fibrosa and the like, but to actual sarcomas of the long bones, both of central and periosteal origin.

Platou, of Christiania, bases his paper on a histological study of 9 cases that have come under his observation, and which he has reported in full.

He takes the position that the so-called giant-celled sarcoma is not a malignant tumor at all, but is properly classed as "giant-celled" tumor. Although he states that the microscopic picture, which he describes in detail, usually shows a peculiar structure which is easily recognized, he further states that it is not possible to give any decisive distinguishing features between sarcoma and giant-cell tumor. According to Platou, "if the resorption of the osseous substances can be shown to take place in connective tissue with few cells (if, in other words, fibrous marrow is found), then that fact would indicate that the bone-destroying process is not of a malignant character." He adds, "The most striking feature of the disease is the enormous giant-cells with 50 to 100 nuclei in one cell. The picture on the whole shows a varied structure with regions rich in cells and bands of

connective tissue, often showing hyaline degeneration; between them every variety merging into tumor-like tissue, also bone substance in the process of formation, resorption, and once in a while islands of cartilage. The cells are mainly round or oval, their protoplasm most often clear and well defined in outline; frequently no intercellular substance can be traced.

"On the other hand, a giant-cell sarcoma under the microscope shows a more homogeneous tissue, with no such extensive spots where cells are few. The shape of the cells is more like a spindle, the intercellular substance more abundant, and besides the giant-cells we find all intervening stages down to cells with 2 to 4 nuclei—a thing rarely seen in the case of giant-cell tumor. We have been told that if giant-cells are seen in clusters this fact would be an indication that the tumor tissue is part of ostitis fibrosa, whereas in the case of sarcoma the giant-cells would be more evenly distributed throughout the tissue."

Platou's series of 9 cases further confirms the opinion long held by Bloodgood and others that a certain number of giant-cell tumors of the long bones, particularly of the tibia, are benign in character, and while easily cured by conservative operation, the limb should seldom, if ever, be subjected to amputation.

Platou, after a careful study of his own cases and those reported in the literature has reached the following conclusions:

"It is deplorable that microscopic examination sometimes permits only a probable diagnosis. The interpretation of the preparation in question will always depend on a personal opinion. There has not yet been discovered any test whereby the diagnosis may become absolutely certain either way when the cases are doubtful.

"The operator, therefore, must take upon himself the responsibility of deciding whether to take the usual consequence of a diagnosis of sarcoma, when he is aware of the fact that the original disease may be ostitis fibrosa, or whether the clinical facts of the case justify a conservative treatment—nay, even demand it."

This is practically the position which I personally have held for a long time, although I believe that resection and transplantation of bone are seldom necessary.

If we could always be sure we were dealing with a benign giant-celled tumor of the long bone, such as Bloodgood describes, simple curetting which he advocates, or in more advanced cases, resection, would suffice. But we must admit that in many instances it is difficult to determine whether a case in question is a giant-celled tumor of benign type, or an actual sarcoma with malignant features. In my own list of giant-celled sarcomas of the long bones, 40 in number, the diagnosis of giant-celled sarcoma was made by a number of leading pathologists. Yet the fact that out of these 40 cases 8 died of metastases proves that in certain cases, at least, the tumor was of a very different type from that described by Bloodgood and Platou.

Perhaps in the light of more recent study of these tumors it may be possible to differentiate, in a larger number of cases, the malignant giant-celled tumors from the benign. But at the present time, we must admit there are few that are able to make the distinction positively.

The following two cases of giant-celled sarcoma which have come under my personal observation were evidently malignant tumors in spite of the fact that the microscopic picture was that of a giant-celled sarcoma of benign type:

A. D., male, aged fifty years, was referred to me on May 29, 1917, and was admitted to my service at the Memorial Hospital with the following history:

In July, 1916, the patient first noticed pain in the region of the right ilium. In December, 1916, he was operated upon for a tumor of the left antrum (patient had had pyorrhea for two or three years preceding, during which time the teeth of the upper jaw had been extracted). The tumor was examined microscopically at the Harvard Medical School by Dr. F. E. Mallory and pronounced "fibrosarcoma, with numerous foreign-body giant cells." A few months after the operation the patient noticed an enlargement of the right ilium, which steadily increased in

size. Physical examination on May 29, 1917, showed a tumor occupying the upper and anterior portion of the right ilium, measuring 5 x 3 inches, markedly soft in consistence, evidently originating in the ilium. A portion removed at exploratory

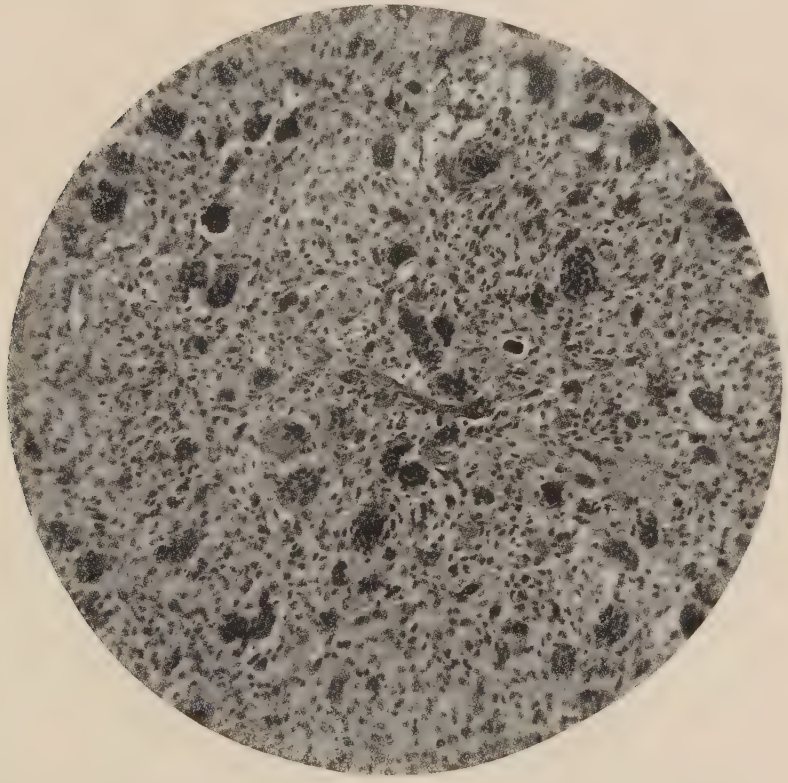


FIG. 1.—Giant-celled sarcoma of epulis type. Specimen removed from metastatic tumor of ilium six months after removal of primary tumor of jaw.

operation was examined by Dr. Ewing and pronounced "giant-celled sarcoma of the epulis type." I believe there can be little doubt that the ilium tumor was a metastasis from the tumor of the jaw. The patient died of cerebral embolism while under toxin treatment.

M. G., female, aged eighteen years, was admitted to my service at the Memorial Hospital on February 6, 1917, with the following history:

Three years previous the patient had a severe trauma, caused by falling off a merry-go-round. One year later she began to

FIG. 2.—Giant-celled sarcoma of the spine. Epulis type. Recurrent after operation Not controlled by either toxins or radium. (Disease progressing when patient left hospital; later history not traced.)

have pain at the exact site of the injury and was admitted to the Post-Graduate Hospital in June, 1915, on the service of Dr. Albee. An exploratory operation was performed and a probable diagnosis of perinephritic abscess was made. No

abscess was found, but some peculiar tissue was removed which was pronounced possibly sarcoma. There was little change in the condition for more than a year (until the early part of 1916), when the pain returned and became more severe, and a swelling developed in the right lumbar region, which was regarded as possibly an enlarged kidney. The patient was admitted to the Memorial Hospital, at which time a tumor mass could be found in the right lumbar region, extending from the first lumbar vertebra downward for three inches to the right spine. I performed an exploratory operation on October 7, 1917; after cutting through a thin, bony shell I came down upon a tumor mass, more or less gelatinous in structure, resembling a myeloid sarcoma. A portion of the tumor was curetted out and examined microscopically by Dr. Ewing, who reported as follows: "Tissue is a giant-celled sarcoma of the epulis type: some bony trabeculæ were found. The main tissue is spindle celled, in which the nucleus is very highly chromatic, but there are no definite evidences of malignancy."

The patient was treated with both toxins and radium, with only slight benefit. When she left the hospital the tumor was increasing in size and the pain was much more severe. A month later she entered Bellevue Hospital and remained there for a short time; since then I have been unable to find any trace of her, but from the condition present at the time she left the Memorial Hospital I feel there is little doubt that the disease progressed to a fatal ending.

That the myelogenous or mixed giant-celled sarcomas, particularly of the lower end of the femur, are, for the most part, true malignant tumors, is well brought out by the statistics of the Bruns Clinic, reported by Kocher in the *Beitr. f. klin. Chir.*, 1906, Bd. 50, Hft. 1, p. 118. In 33 consecutive cases of central myelogenous sarcoma, 4 were too far advanced for amputation or the patient refused it (it is assumed that these ended fatally); of 11 cases in which amputation was performed, 1 died of the operation, 8 died of metastases, and only 2 were known to have been well beyond the three-year period. As no microscopic

sections were published it is impossible to state how many were of the "giant-celled type" described by Bloodgood and Platou. If none was of this type it only confirms my own opinion that the benign giant-celled tumor of the femur is comparatively rare, especially when accompanied by the clinical signs of malignancy, rapid growth and extensive invasion of the surrounding tissues, especially the knee-joint.

My own series of cases shows that in a small number of cases of periosteal and highly malignant tumors of the long bones, the limb as well as the life of the patient can be saved by the prolonged use of the mixed toxins of erysipelas and Bacillus prodigiosus, and even a larger number of cases with tumors of central origin of unmistakably malignant type, can likewise be saved.

If the tumor appears almost certainly benign, curetting alone will probably prove sufficient to effect a cure, but my own experience, covering 250 cases of sarcoma of the long bones, with 40 of the giant-celled type, shows that this type of tumor of the long bones is comparatively rare. I should hesitate to place complete reliance on the microscopic examination alone, unless fully supported by the clinical history and the *x*-ray pictures. Bloodgood's report of 43 cases of benign giant-celled tumors of the long bones, gives one, I think, a mistaken impression of the relative frequency of the condition—an impression which might be corrected by remembering that Bloodgood's interest in this subject dates back many years and his frequent reports of cases have influenced surgeons all over the country, to send him special cases, resulting in his being able to report a personal observation of 43 cases of what may still be regarded as a comparatively rare type of tumor.

In dealing with periosteal tumors we have an entirely different proposition. Here there is no longer any doubt about the malignancy of the tumor, and all agree that even the most radical operation rarely saves the life of the patient. The hopelessness of the condition warrants us in trying almost any method of treatment that offers the slightest prospect of saving the limb, and this very hopelessness justifies us, I believe, in

making an exploratory operation in order to definitely establish the diagnosis at the earliest moment. The microscopic diagnosis of periosteal sarcoma is, in most cases, much less difficult than in the tumors of central origin, but in certain rare cases one also encounters similar difficulties. In a few cases it may be entirely impossible to make a positive diagnosis (histologically), yet the clinical history and physical signs leave little doubt that we are dealing with a periosteal sarcoma. Formerly I advised amputation in these advanced periosteal cases, until I found that in a number of cases in which the patients absolutely refused amputation I was able to save the limb as well as the life of the patient by the use of the mixed toxins. In one of these cases recovery took place after metastases had developed.

The result in these cases, I believe, justifies us in treating even periosteal sarcomas by conservative methods. The question naturally arises: should we limit the treatment to the mixed toxins or to radium alone, or a combination of both. We know that the toxins, without any other agents, have cured the disease, saved the limb and the patients have remained well for many years afterward. This is true of every type of sarcoma, both periosteal and central. As far as I know, few cases have been cured by radium alone. The only case reported in which the patient remained well five years, is that of Pinch of the London Radium Institute, 1918. No details of the case, however, have so far been published, nor do we know the nature of the histological structure of the tumor.

I have had under observation a case of periosteal sarcoma of the femur which failed to improve under a month's toxin treatment, and I then advised amputation followed by toxins. The patient later placed himself under the care of the late Dr. Joseph Bissell, who gave him repeated radium treatments. The tumor apparently disappeared and he remained well nearly two years, when he had a local recurrence which was not controlled with massive doses of radium. I then amputated below the trochanter, but lung metastases soon developed, and spinal metastases, causing death in a few months.

We have had two cases at the Memorial Hospital during the

last year in which the tumors have apparently disappeared under the use of radium alone. One was a large tumor of the upper end of the humerus, pronounced chondroma from tissue removed at exploratory operation, but in view of the large size and rather rapid growth it was believed by Doctor Ewing to be chondrosarcoma. This tumor showed remarkable disappearance under radium treatment administered by Doctor Janeway,

FIG. 3

in the form of bare tubes introduced into the tumor substance, supplemented by massive doses of radium in the form of a pack. The sinus, however, persisted, and an examination of a recent curetting in May, 1919, showed the presence of a "degenerating chondrosarcoma."[1] No active chondrosarcoma was found in this

[1] Patient has been steadily losing in weight and strength during the last few months, and when last heard from, a month or so ago, was at the point of death.

curetted material but only broken-down fragments of necrotic tumor tissue. The other case was a small giant-celled sarcoma of the upper end of the tibia, which is still well a little less than one year. In view of these results it would seem that the interest of a patient suffering from sarcoma of the long bones may be best served by giving him the benefit of combined treatment, *i. e.*, the systemic effect of the toxins with the local action

FIG. 4

of radium. If the tumor does not show marked improvement in the course of four or five weeks under this treatment, I would advise amputation followed by the use of the toxins as a prophylactic against recurrence, that is, if the disease is not too far advanced for amputation.

Resection with or without bone implantation is, I believe, seldom indicated. The cases I have reported in full, especially the tibia case with complete destruction of the upper five inches

of the tibia, treated conservatively by curetting, toxins and radium, with almost complete restoration of the destroyed bone, and the patient well nearly four years, shows how much Nature can do if the sarcoma has been completely destroyed.

It is difficult to estimate the definite percentage of cases in which one may succeed in saving the life and limb in sarcoma of the long bones. It depends largely upon the stage of the

Fig. 5

disease at the time conservative treatment is begun; the percentage will be much higher in the cases treated at an early stage than in those treated at a later stage.

Nevertheless, my series of cases shows several cures in which the disease was so far advanced as to be entirely beyond hip-joint amputation. These cases show that few, if any, should be regarded as so desperate as not to warrant an attempt to save the limb as well as the patient's life. In a very large number

of my cases the disease has been too far advanced for amputation, so that this series does not give a fair idea of the results which might have been obtained had the disease been treated at an earlier stage. However, they give some idea as to the number of recoveries that may be looked for in advanced cases. If we

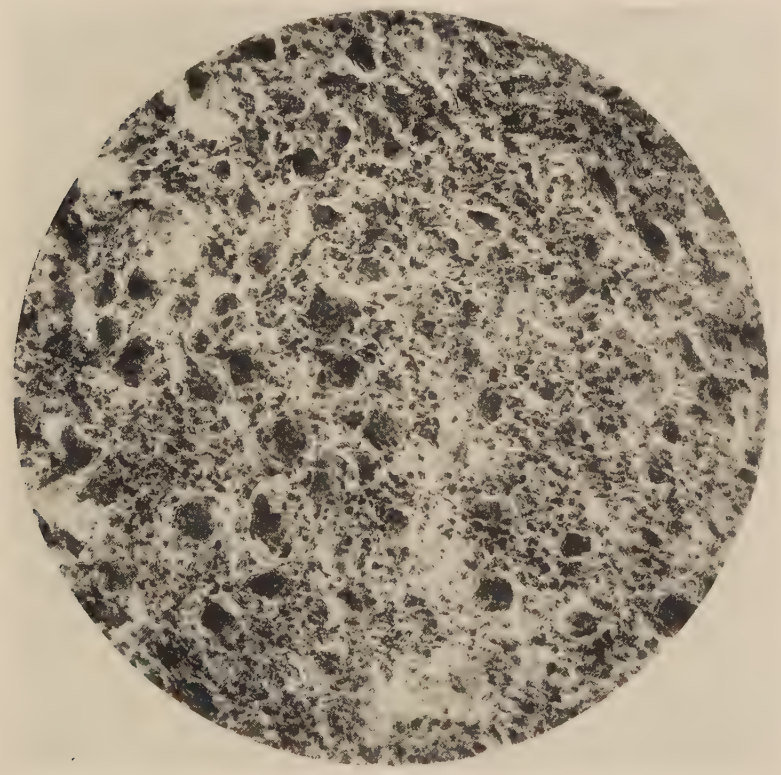


FIG. 6.—Giant-cell sarcoma of the femur, epulis type, recovering under simple curetting. Amputation advised and refused. Well in two years. Example of typical giant-celled tumor of low degree of malignancy.

are able to cure a considerable number of patients with the disease too far advanced for amputation, we certainly have a right to expect a much larger number of recoveries in cases seen and treated in the early stages of the disease.

As the earlier cases have already been reported before the American Surgical Association, I think it may be of interest to give a brief analysis of the cases treated within the last five years. During this period I have had under treatment 60 long-bone cases, classified as follows: Femur, 32; humerus, 14; tibia,

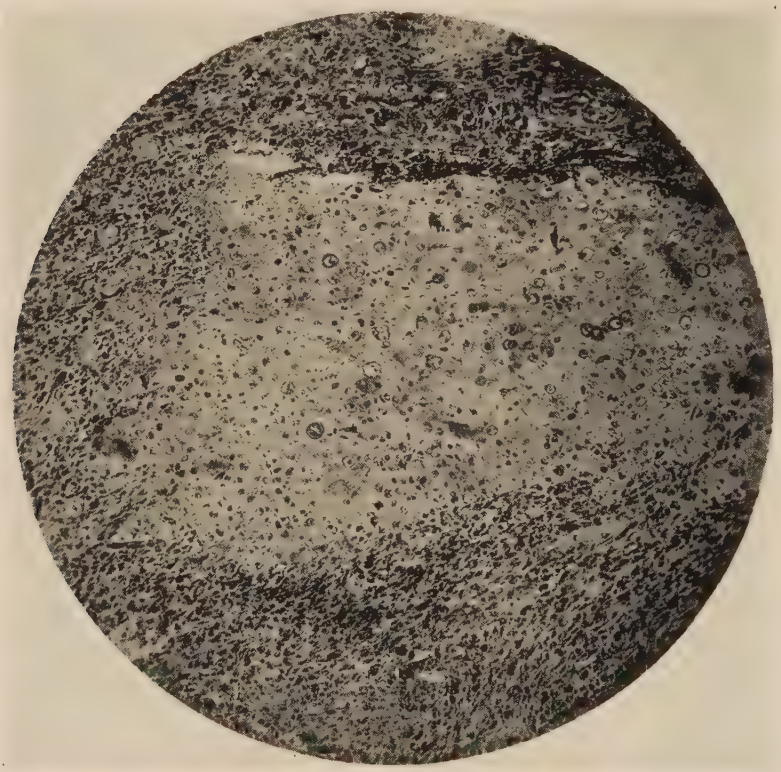


Fig. 7.—Spindle-, round- and giant-cell chondrosarcoma. Death from metastasis in lung three years after amputation.

9; fibula, 3; clavicle, 2. Of the 32 femur cases, amputation was performed in 13 cases after conservative treatment had failed (there was no mortality from operation); in 4, amputation was strongly advised but refused by the patient. Eleven of these patients are still living, 2 being recent cases still under

treatment, with a reasonable prospect of saving the limb. One of the patients who refused amputation had a large central sarcoma of the lower end of the femur, which was treated with toxins and radium, with slight temporary improvement; metastases later developed in the lung and the patient lived but a few weeks. One periosteal sarcoma had toxins followed by amputation; well three years when a recurrence developed. One central sarcoma of the lower end of the femur with extensive involvement of the knee-joint, refused amputation, and recovered under the toxins alone; well five years. One extensive sarcoma of the lower end of the femur involving the knee-joint and upper end of tibia, in which amputation was refused, was treated with toxins supplemented by radium, and is well now three years, walking without support of any kind. One very large inoperable sarcoma of the upper half of the femur, quite beyond hip-joint amputation, recovered under toxins and radium and is well at present without any evidence of the disease two years later. Two cases of periosteal sarcoma of the femur treated with radium and toxins during the last six months in the hope of saving the limb, result still doubtful. In 3 cases of sarcoma of the femur, amputation was performed followed by the use of the mixed toxins as a prophylactic against recurrence; 2 cases are still well three years later, and the third died of metastasis nearly three years after amputation.

Following is a brief report of cases containing points of special interest:

NOTE.—Recurrence has taken place in one of these cases in October, 1919.

Cases I and II have been reported in Transactions of New York Surgical Society with microphotographs of tumors in *Annals of Surgery*, March, 1917.

CASE I.—*Central Sarcoma of the Lower End of the Femur with Extensive Involvement of the Knee-joint, Successfully Treated with the Mixed Toxins.* L. G., female, aged twenty-one years, was first seen in consultation with Dr. V. P. Gibney, at the Hospital for Ruptured and Crippled, in October, 1914. Family history

negative, Wassermann negative; no history of antecedent trauma.

Eight months previously patient first noticed pain in the left knee, while walking up and down stairs. This gradually increased in severity and shortly after was present even while walking on level surfaces. She consulted a physician who made a diagnosis of tubercular disease and applied Buck's extension to the knee, with slight temporary relief. A little later she entered a hospital where a plaster-of-Paris splint was applied, which she wore for five weeks. No improvement was noticed; thereupon several teeth were removed, on the ground that she was suffering from osteoarthritis due to pyorrhea. Later on she was placed upon specific treatment. In spite of these widely varied therapeutic measures, the swelling and pain increased, and the patient was unable to bear the weight of her body upon the limb. She was admitted to the Hospital for Ruptured and Crippled (Doctor Gibney's service) on October 24, 1914, at which time physical examination showed general condition good; heart and lungs normal, patient wearing a plaster splint. She had lost considerable in weight. There was marked swelling and infiltration of the whole lower end of the left thigh and anterior aspect of the left knee. The knee was completely extended, with very greatly increased abnormal lateral motion, showing destruction or extreme laxity of the tissues. There was marked infiltration of the popliteal space, and moderate atrophy of the limb.

Measurements. Left, 15, 15½, 12; right, 14¼, 14, 12.

The *x*-ray showed very marked expansion of the lower extremity of the femur; cortical substance thin and apparently on the point of breaking through; structure of bone has disappeared.

In view of the extensive involvement of the knee-joint, accompanied with great tenderness and extreme mobility, after careful examination and study of the *x*-ray plates, I concluded that the disease was undoubtedly a central sarcoma which had pierced the cartilage of the joint, causing joint involvement and effu-

sion. This condition is extremely rare and I had never, up to that time, seen a case similar to it with such extensive joint involvement. Doctor Gibney and Doctor Whitman also believed the condition to be sarcoma. All of us considered it too far advanced to justify conservative treatment, and strongly urged immediate amputation. This, however, was refused by the patient and her family. On November 6, 1914, an exploratory operation was made to obtain a piece for microscopic examination. On cutting down to the periosteum, a mass was found which occupied the entire lower end of the femur, the central portion of which was greatly expanded and occupied by a tumor having the typical clinical appearance of a sarcoma. It was quite vascular and penetrated into the joint; there was considerable effusion in the joint. As much of the tumor as possible was curetted and the wound packed. Hemorrhage, which was severe, was fairly well controlled with tight packing, and the limb was put in a plaster-of-Paris splint. After microscopic examination Dr. F. M. Jeffries, pathologist to the Hospital for Ruptured and Crippled, reported it as a "mixed-celled sarcoma."

A further examination was made by Dr. J. Ewing, who reported as follows:

"The material consists of several broken portions of tumor tissue, each about 1 cm. in diameter.

On section the masses are composed of dense fibrous tissue, in many places hyaline, covered with a fringe of sarcomatous tissue of the type of giant-cell sarcoma. The giant-cells are of the epulis type. There are a few trabeculæ of bone which are separated by spindle tumor cells and are undergoing absorption. In several places the dense fibrous tissue is infiltrated by strands of tumor tissue in which the cells are spindle in form, with slightly hyperchromatic nuclei, but without admixture of giant cells.

In the absence of full data regarding the anatomy of the tumor and its clinical course, it is impossible to give any positive opinion of the clinical malignancy of the case. The giant-cell areas belong in a group which generally pursues a benign

course. The spindle-cell areas seem to possess greater growth capacity."

X-ray examination, November 11, 1914, showed an attempt at formation of a new joint; shaft of femur resting on the outer articular surface of the tibia. Over the inner articular, to correspond with the inner condyle, is new bone formation, making a contour of a fairly good joint; no ankylosis between

FIG. 8.—(Case I.) Central sarcoma of femur before treatment, involving knee-joint and upper end of tibia. Treated by curetting, toxins and radium. Complete recovery—well, and walking with scarcely any limp three years later.

femur and tibia. Lateral view shows new bone formation, anterior to the patella; appears to be some ankylosis with the patella; no evidence of metastasis.

A few days after the exploratory operation the patient was put upon the mixed toxins of erysipelas and Bacillus prodigiosus, and the doses were carried up to the point of giving a severe reac-

tion. The toxins were begun on November 11, 1 minim, and increased daily by $\frac{1}{2}$ minim, until December 27, when $8\frac{1}{2}$ minims (the highest dose) was reached, which produced a temperature

FIG. 9.—(Case I.) Sarcoma of lower end of femur with extensive involvement of knee-joint. Amputation advised and refused. Recovered under systemic treatment with mixed toxins alone. Patient is walking without crutch or cane at present (four years and eight months). This photo, showing extensive growth of new bone, was taken four years and eight months after beginning of treatment. Patient still wears a brace.

of 104°. After this, a short interval of one week's rest was given; the toxins were then resumed, and kept up for one year with occasional brief periods of rest, seventy-three injections in all being given.

On December 2, 1915, Doctor Gibney reported that there was no deformity; the limb was straight, with little, if any, motion. Two days later, December 4, the patient was discharged from the Hospital for Ruptured and Crippled wearing a brace on the right leg.

Inasmuch as the sinus had failed to heal the patient was given an anesthetic and through-and-through drainage was established; curettings carefully examined by Doctor Ewing failed to show any evidence of malignancy. Rubber tubes were inserted and kept in for a number of months.

Patient was readmitted to the Hospital for Ruptured and Crippled on March 7, 1916, for infection of the old sinus. Just before admission, she developed pain and slight fever. Examination revealed what was apparently an inflammatory enlargement of the knee with a boggy swelling of the popliteal region. These symptoms continued and later fluctuation developed. In March, under local anesthesia, an incision was made in the popliteal opening and a small abscess was found which apparently communicated with the old sinuses. One of these was opened and curetted and both openings were drained. Examination of curettings again failed to show evidence of malignancy. She was shortly treated with "Dakin's fluid" and rapid healing followed. The toxin treatment was resumed for a brief period.

The patient was shown before the New York Surgical Society in November 22, 1916, and again in January, 1919. She was also presented at the meeting of the American Surgical Association on June 16, 1919, at which time she was in good health with no trace of a recurrence, over four years later. She has $2\frac{1}{2}$ inches of shortening and walks with a brace, without crutch or cane. (She is still well October 25, 1919.)

Case II.—*Extensive Sarcoma of the Upper End of the Tibia Involving the Fibula.* C. M., female, aged seventeen years, was admitted to the Hospital for Ruptured and Crippled on July 22, 1915, with a history of having first noticed trouble in the upper part of the right leg, just below the knee-joint, six months prior to her admission. This consisted of a small swelling on

the inner side of the upper portion of the right tibia, slight amount of pain, increasing disability, and moderate loss of weight; no enlargement of glands in the groin. At the time of her admission to the hospital she presented a symmetrical enlargement of the whole upper portion of the right leg, most marked below the patella. The limb could be flexed to about a right angle; no muscular spasm. Over the inner portion, the tumor was extremely soft on palpation, having the "feel" of semi-fluctuation.

Measurements.—Right, $11\frac{1}{2}$, 12, $12\frac{3}{4}$, $12\frac{3}{4}$; left, $11\frac{1}{2}$, $11\frac{5}{8}$, $11\frac{1}{2}$, $10\frac{3}{4}$. *X*-ray showed a tumor involving the entire upper extremity of the tibia, the bony structure of which was practically destroyed except on the outer and upper aspect; other bones not affected. The disease was so extensive that amputation was strongly advised, but refused by the patient. In view of the successful results obtained with the toxins in the case of sarcoma of the femur, already detailed in this paper, conservative treatment was advised in the present case, *i. e.*, curetting for a microscopic section, to be followed by toxin treatment. In this opinion Doctor Gibney concurred.

On August 2, 1915, a four-inch vertical incision was made below the knee. The tumor was curetted out, and found to involve the whole upper part of the tibia for a distance of four inches, and nearly the same length of the fibula, with the exception of the outer wall; a thin layer of cartilage which was perforated in curetting was all that was left of the upper end of the tibia. The wound was packed with gauze, and a roller bandage tightly applied and the limb put up in plaster of Paris before removing the tourniquet. Pathological examination was made by Dr. F. M. Jeffries (pathologist to the Hospital for Ruptured and Crippled), who reported the tumor to be "giant-celled sarcoma."

Dr. James Ewing also examined a section microscopically and reported: "Tissue composed of typical giant-cell sarcoma of epulis type and of very moderate malignancy."

A third examination was made by Dr. George Barrie, of the

Post-Graduate Hospital, who pronounced it "fibrosarcoma with giant cells." He stated it was a true sarcoma and not a benign tumor. The clinical history of rapid development and exten-

FIG. 10.—(Case II.) Sarcoma of tibia three years and ten months after toxin and radium treatment showing reformation of upper five inches of tibia without bone grafting and after complete destruction by sarcoma. Treated by toxins and curetting, August, 1915, after amputation had been strongly advised by other surgeons. Patient well in four months. Then recurred and grew rapidly. Second curetting. Rapid recurrence. Disappeared under toxins and radium. Well October 26, 1919, more than four years.

sive involvement furnish sufficient evidence of the malignant nature of the tumor. Blood examination August 10, 1915: Red blood cells, 4,700,000; hemoglobin, 85 per cent.

Four days after curetting, the patient was put upon small doses of the mixed toxins of erysipelas and Bacillus prodigiosus (no other treatment). The initial dose, $\frac{1}{2}$ minim, was increased daily, by $\frac{1}{2}$ minim, until a decided reaction temperature of 102°, 103°, 104° was obtained, after which four injections a week were given.

FIG. 11.—Same case as Fig. 10, three years and ten months after treatment.

The cavity gradually filled up with healthy granulations, and a note by Dr. V. P. Gibney, dated November 15, 1915, reads: "Open sinus over inner head of tibia; no infiltration about knee. Small range of motion allowed, not fully tested. General condition excellent. On high road to recovery."

The leg and thigh were kept in a plaster splint and the sinus treated through a window in the splint. By December 1 the sinus had closed and there was no evidence of any tumor either by physical or *x*-ray examination. *X*-ray pictures were taken regularly every two weeks. Marked new formation of bone could be noticed in the upper end of the tibia, which was completely destroyed at the time of operation. The patient also gained in weight and strength. On December 27, 1915, she was shown before the Alumni Association of the Hospital for Ruptured and Crippled, at which time there was no evidence of any lesion present.

On January 9, 1918, the patient suffered from an attack of grippe and the toxin treatment was discontinued for two weeks. On January 26, the plaster cast was removed and a recurrent tumor the size of a pullet's egg was found at the upper and inner end of the right tibia, at the site of the old sinus. An *x*-ray picture also showed the growth. The toxin treatment was again administered and given both locally and systematically. The tumor diminished somewhat in size but did not disappear, and on March 3, 1916, a portion of the growth about the size of a hen's egg was removed by curette and the wound was packed. A microscopic examination of the mass removed was made by Doctor Ewing, who pronounced it "giant-cell sarcoma." Blood examination, March 5, 1916: Red blood cells, 4,856,000; white blood cells, 7800; hemoglobin, 82 per cent.

On March 10, 100 mg. of radium emanations were applied over the site of the tumor, and allowed to remain for twenty-four hours. The toxin treatment also was resumed, the doses being increased every day up to the point of producing a temperature of 102° to 103°. The soft tumor-like area slowly increased in size and by April 1 it measured 1 by $\frac{3}{4}$ inch; it was non-fluctuating. On April 8, 150 mg. of radium emanations were applied to the lower and ulcerated portion of the swelling, and kept on for seven hours, after which it was moved 2 inches higher over the articular surface of the tibia. On July 22, 240 mg. of radium were applied over the same site for fourteen

hours. Her local condition continued to improve, the sinus gradually healed, and the patient's general condition returned to normal. The toxins were continued during the summer with occasional intervals of rest.

On October 4, 1916, when she left the hospital, there was no sign of a tumor and she was in good physical condition. By November 22, 1916, she had gained twenty-four pounds in weight.

This patient also was shown before the New York Surgical Society on November 22, 1916, and again in January, 1919, and was presented at the meeting of the American Surgical Association on June 16, 1919, at which time she was in good health with no evidence of local recurrence or metastases. She now walks with a brace without the aid of a crutch or cane. The recent *x*-ray pictures show almost complete restoration of bone. (Well October 25, 1919, over four years.)

CASE III.—*Periosteal Sarcoma of the Tibia with Metastases in the Inguino-femoral Glands; Disappearance under Toxin and Radium Treatment; Well at Present, Nearly Two Years.* Mr. S., aged thirty-nine years, was referred to me on April 27, 1917, by Dr. John H. Gibbon, of Philadelphia. Family history negative.

Personal History. The patient's general health had been very good, and he had practically never been ill. Ten years before he was struck by an automobile and suffered a compound fracture of the right leg, four inches above the ankle. There had been no injury to the left leg as far as known. Three weeks before he was referred to me the patient had noticed a swelling about two inches above the left ankle, extending upward and involving the inner and anterior portion of the leg for a considerable distance. It was at first believed to be a periosteitis of inflammatory origin. In the latter part of April Doctor Gibbon was called in consultation and pronounced it a sarcoma. This opinion was strengthened by an *x*-ray examination.

Physical examination at the time of my first observation (April 27, 1917) showed a man in robust health. Examination

of the left leg revealed a marked swelling occupying the lower third, apparently originating in the periosteum and extending nearly around the leg. It began about an inch above the internal malleolus and extended upward five inches anteriorly, and four and a half inches on the outer side of the fibula. There

FIG. 12.—(Case III.) Periosteal sarcoma of tibia, spindle-celled.

was marked edema of the whole lower third of the leg extending to the ankle. The swelling, which was most prominent over the inner and anterior part, was soft, almost semi-fluctuating, and markedly tender on deep pressure; the skin was slightly discolored. T. = 99 : 5°.

To definitely settle the diagnosis, on April 27 an exploratory

operation was made. A portion removed was examined microscopically by Doctor Ewing, who reported: "Section shows a tumor composed of small spindle cells consisting chiefly of nuclei. They are very numerous, with no visible stroma. The cell masses are very compact. The tumor is quite malignant in structure."

FIG. 13.—(Case III.) Two years later, spindle-celled periosteal sarcoma of tibia. Very rapid development.

The patient was immediately put upon the mixed toxins of erysipelas and Bacillus prodigiosus, which were continued four or five times a week in doses sufficient to produce a temperature of 102° to 104°.

MEASUREMENTS

April 30, 1917:

1 inch above the internal malleolus = $9\frac{5}{8}$ inches
4 inches above the internal malleolus = $10\frac{5}{8}$ inches
6 inches above the internal malleolus = $10\frac{3}{4}$ inches
The tumor itself = 4 x 3 inches.

May 5, 1917:

4 inches above the internal malleolus = $10\frac{3}{8}$ inches
6 inches above the internal malleolus = $10\frac{3}{8}$ inches
The tumor itself = $4\frac{1}{2}$ x 4 x $3\frac{1}{2}$ inches.

May 11, 1917:

4 inches above the internal malleolus = $9\frac{3}{4}$ inches
6 inches above the internal malleolus = $9\frac{3}{4}$ inches
The tumor itself = 4 x 3 inches.

On May 1, 1917, the patient was treated with radium emanations 12 by 85 mc. (1020 mc.) through 2 mm. lead filter, 6 cm. distance, applied to the anterior surface of the leg for twelve hours.

On May 8 he received the following radium emanations: 660 mc., 2 mm. lead filter, 10 cm. distance, applied to the inner aspect of the leg for twelve hours, and on May 23 the same amount of radium emanations, 2 mm. lead filter, 6 cm. distance, applied to the external aspect of the leg for twelve hours.

MEASUREMENTS

May 21, 1917:

Circumference of leg across center of scar = $9\frac{1}{4}$ inches

May 25, 1917:

Circumference of leg across center of scar = $9\frac{1}{4}$ inches
Circumference of leg across upper end of scar = $9\frac{9}{16}$ inches
Circumference of leg across lower end of scar = $9\frac{9}{16}$ inches

On May 26, 1917, the patient returned to his home, where the toxins were continued three times a week by Dr. R. G. Gamble, his family physician, and on June 19 he was again admitted to the Memorial Hospital for further radium treatment, at which time he received 1200 mc. emanations, through 2 mm. lead filter, 10 cm. distance, applied to the internal surface of the leg for eight and one-half hours. The toxins were then con-

tinued at home during June and July, but in view of the fact that all evidence of the disease had disappeared and he was in

FIG. 14.—(Case III.) Periosteal sarcoma of the tibia. No giant cells. Entire disappearance followed the use of toxins and radium, April, 1917. Recurred in glands of groin (femoral, inguinal and iliac) September, 1917. Diagnosis was confirmed by microscopic examination. Disappeared under further treatment and toxins were continued for two years. Patient well (February 1, 1920) without trace of disease. Microscopic examinations both made by Dr. Ewing. Diagnosis: Malignant spindle-celled sarcoma, no giant cells.

such fine general condition it was thought safe to discontinue the treatment for four weeks during the extreme heat in August and September.

The patient returned to Doctor Coley for observation on September 15, 1917, stating that he had recently discovered a swelling in the left groin, which was increasing in size. A

FIG. 15.—(Case III.) Section from metastatic tumor removed from inguinal region. Metastatic tumor six months later in groin, which disappeared under toxin and radium treatment. Again disappearance under same treatment and patient well and free from recurrence February 1, 1920, nearly three years from time treatment was begun.

physical examination showed the leg to be apparently normal. The left groin was occupied by several large glands involving the femoral, inguinal and iliac regions, the largest of which was about the size of a big hickory nut. This was removed under

general anesthesia and forwarded to Doctor Ewing for microscopic examination, who reported: "Actively growing sarcoma. Cells large polyhedral. No pigment. Nature of origin uncertain."

RADIUM TREATMENTS

October 1, 1917. Radium emanation pack, 600 mc. for seven hours, 2 mm. lead filter, applied at a distance of 10 cm. to the left inguinal and femoral regions.

October 2, 1917. Radium pack, 480 mc., lead filter for twenty-nine hours, at a distance of 10 cm. to the same region, making a total of 18,000 mc. hours.

November 8, 1917. Radium pack, 1400 mc. (2 mm. lead, 0.5 mm. German silver), applied at a distance of 8 cm. over the left inguinal region for six and three-quarter hours.

November 9, 1917. Radium pack, 1420 mc. (2 mm. lead, 0.5 mm. German silver), applied at a distance of 8 to 10 cm. over the left inguinal region for six hours.

December 7, 1917. Radium pack, 1800 mc. for six and two-third hours (2 mm. lead, 0.5 German silver), applied over the left inguinal region at a distance of 8 to 9 cm.

The toxins have been continued for nearly two years with occasional intervals of rest. The doses have been comparatively small, not sufficient to interfere with his regular occupation, and his general health has remained perfect throughout the entire time. A recent physical and *x*-ray examination showed apparently no trouble remaining in the tibia and no evidence of metastases in any other part of the body.

This case, I believe, illustrates the advantage of combining the local effect of the radium with the systemic effect of the toxins; it also shows the importance of keeping up the toxin treatment in certain cases for a considerable period. It is too early yet to say that the patient is permanently cured, yet more than two years have elapsed since the disappearance of the primary tumor, and one and a half years since the secondary. This patient was shown before the American Surgical Association June 16, 1919, at Atlantic City.

NOTE.—The patient was shown before the Clinical Congress of Surgeons of America in New York October 23, 1919, without trace of recurrence, in two and a half years. The patient is now well, February 1, 1920.

CASE IV.—*Central Sarcoma of the Femur with Extensive Involvement of the Knee-joint and Upper End of Tibia. Amputation advised, but refused; recovery under conservative treatment, curetting followed by systemic toxin injections and radium treatment; well at present, two years and seven months.* C. S.,

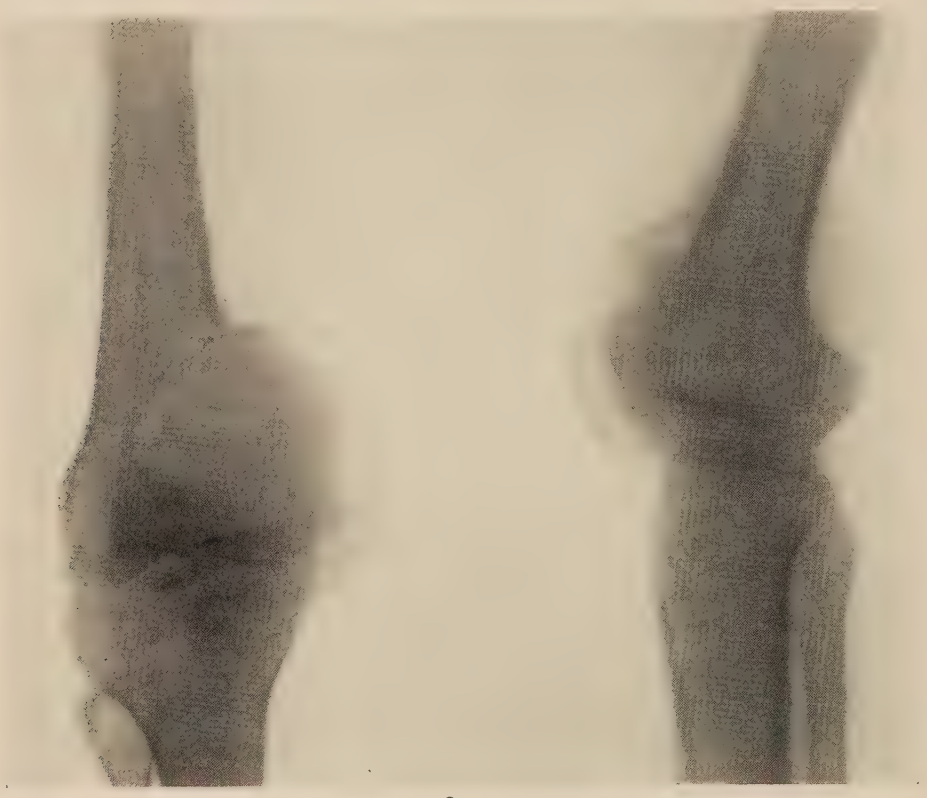


FIG. 16.—(Case IV.) Central sarcoma of femur. Giant- and spindle-celled. Rapid growth, involving the knee-joint and upper end of tibia.

female, aged twenty-nine years; married; family history good. Referred to me November 10, 1916; first noticed swelling over the inner condyle of the right femur seven months previously; the swelling was associated with a moderate amount of pain; admitted to St. Vincent's Hospital a few weeks before I saw her.

An x-ray picture was taken and the diagnosis of sarcoma made; amputation strongly advised, but refused.

Physical examination November 10, 1916, shows a tumor occupying the whole lower end of the femur, most prominent over the anterior and inner portion, apparently involving the

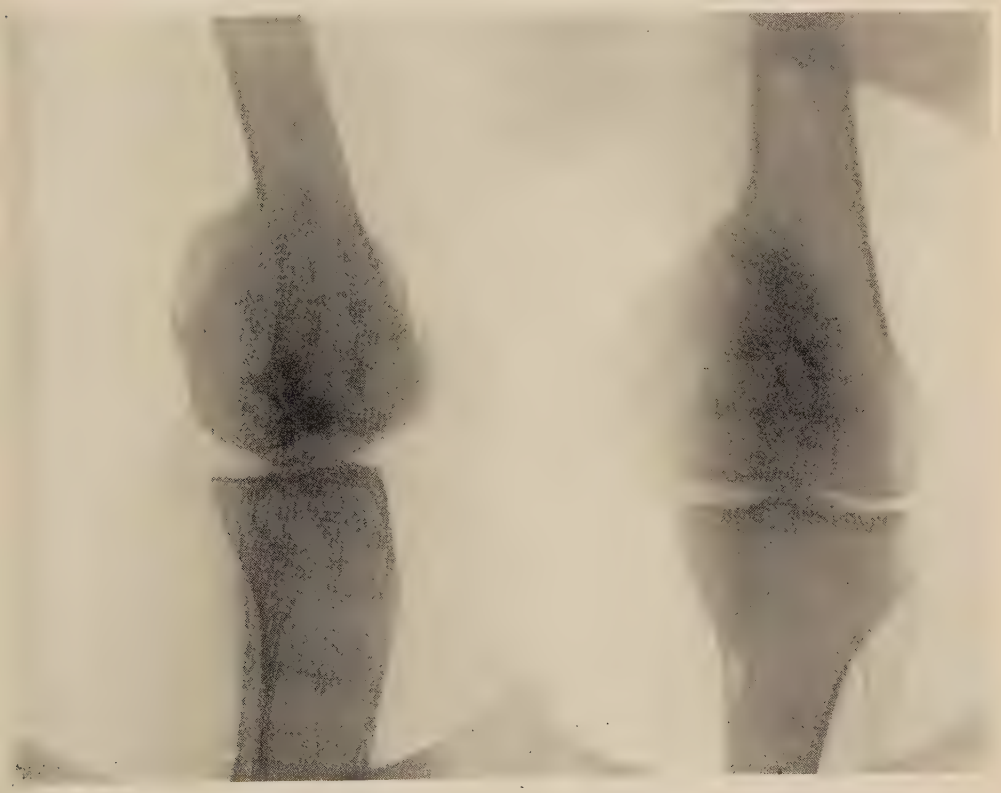


FIG. 17.—Same case as Fig. 11 two and one-half years later.

knee-joint. The tumor is soft and semi-fluctuating over most of the area, consistence varied in different portions. On the inner side the swelling extends down to and apparently involves the upper end of the tibia; it is smooth and globular in appearance; superficial veins dilated. Measurements of tumor—$6\frac{1}{2}$ inches on the inner side; 7 inches on the anterior; $5\frac{1}{2}$ inches on

the outer. Measurement over most prominent part of the tumor, $16\frac{1}{4}$ inches, 2 inches more than on the normal side. The

FIG. 18.—Spindle- and giant-celled sarcoma of femur involving knee-joint and upper end of tibia. Amputation advised by several surgeons and then at St. Vincent's Hospital, but patient refused and was discharged. Amputation strongly urged by Dr. Coley and refused. Patient then treated by Dr. Coley by exploratory operation—curetting—followed at once by large doses of toxins. Cavity size of an orange healed by granulation. 100 mc. of radium inserted in sinus by means of steel needle and radium pack used externally. Patient well October 26, 1919, nearly three years.

popliteal space is partially filled up with a new growth of bone. The patient has been unable to walk for five months, and has

lost 25 pounds in weight. Clinical diagnosis: Central sarcoma of the femur with extensive involvement of the knee-joint. *X*-ray examination shows a tumor occupying almost the entire lower end of the femur, apparently involving the knee-joint as well. There seems hardly any of the femur left, except the lower portion of the outer condyle. Amputation was strongly advised, but the patient absolutely refused. I finally decided to make an exploratory operation and to treat the patient with large systemic doses of the toxins of erysipelas and Bacillus prodigiosus, possibly supplemented by radium. Operation, November 15: A tourniquet was applied at the upper and middle third of the right thigh and an incision 4 inches long made over the inner condyle along the inner border of the patella. A tumor, soft and semi-fluctuating, about the size of an orange, was found underneath the muscular layers. It had broken entirely through the periosteum, and while not actually infiltrating, had pushed to one side and outward the muscles and fascia. By means of a curette and gauze sponges a large mass of soft grumous material of grayish red color, macroscopically typical of sarcoma, was removed. The semilunar cartilages had been apparently entirely destroyed. The upper portion of the tibia for a distance of about 2 inches was almost completely destroyed and the whole joint was disorganized and occupied by a tumor which extended nearly through the outer condyle of the femur. The fibula was apparently not involved. Only a small shell of the outer side of the femur prevented spontaneous fracture. The tumor was finally curetted down to hard bone on the outer side and to the muscle and fascia overlying the popliteal vessels below, and to the upper end of the tibia until bare bone was reached. A cavity fully the size of an orange remained, which was packed tightly with gauze to prevent hemorrhage, and the limb put in a plaster splint. A pathological examination was made by Dr. James Ewing, who reported as follows: "The tumor has the general features of a giant-celled medullary sarcoma. Several areas are unusually cellular, which indicates a guarded prognosis." In a later report made on basis of examination of further sections, he

states: "While the tumor shows certain areas of typical giant cells, there are other areas in which the giant cells are comparatively few in number and bunches of spindle and round cells are present."

This report taken in conjunction with the clinical history of the case, the very rapid growth of the tumor, perforation of the periosteum, complete destruction of the knee-joint and involvement of the upper end of the tibia, leave little doubt in my own mind that the tumor was a sarcoma of marked malignancy and could not be regarded as a giant-celled growth of benign character.

The packing was not completely removed until the end of a week, and the large cavity was kept clean by the use of Dakin's solution. Three days after the operation the patient was put upon systemic doses of the mixed toxins, the injections being made into the buttocks; the initial dose was $\frac{1}{2}$ mm., and this was increased by $\frac{1}{2}$ mm. daily up to the point of obtaining marked reactions. The highest dose was 14 minims. The patient was not very susceptible, and severe reactions did not occur until very large doses (10 to 12 mm.) were reached. The large cavity gradually filled up with apparently normal granulation tissue. At the end of about two months the wound had practically closed without the slightest infection. Frequently taken *x*-ray pictures showed steadily increasing reproduction of bone at the site of the tumor.

The patient was shown before a conference at the Memorial Hospital on January 24, 1917, with the sinus healed, and able to get about on crutches. Just before the sinus had entirely closed, the toxin treatment was supplemented by the introduction of steel needles containing 100 mc. of radium, through the sinus at the bottom of the cavity; the needles were allowed to remain in place for three hours on three occasions. Later a radium pack treatment was given externally.

The patient made an uninterrupted recovery. For the last two years she has been attending to her household duties without the use of crutch or cane. She was shown at a clinic given for the Clinical Congress of Surgeons of North America October

23, 1919, three years after treatment, and walked with only a slight limp and was apparently in normal health. The *x*-ray picture shows that the original tumor area has been almost entirely replaced by new bone, and the limb is apparently as strong as it ever was. *X*-ray picture of the chest shows no evidence of metastases.

CASE V.—*Very Large Inoperable Periosteal Sarcoma of the Upper Portion of the Femur, Following a Recent Fracture; Disappearance Under Combined Toxins and Radium Treatment. Reunion of Pathological Fracture; Well at Present, Two Years after Beginning of Treatment.* R. H., male, aged thirty-six years, had been entirely well up to January, 1917, when he slipped on the ice, causing a fracture of the left femur, a little below the trochanter. He was taken to St. Vincent's Hospital in Bridgeport, Conn., where he was treated by Dr. Geo. W. Hawley. *X*-ray pictures had been taken at the time, but owing to Doctor Hawley's having been engaged in military service, I have been unable to see the pictures as yet. The hospital report, however, mentions nothing more than an oblique fracture below the trochanter. If there had been a pathological fracture due to a tumor already present, it probably would have been discovered at the time of the first *x*-ray picture. The patient did well for nine weeks, at the end of which time a swelling appeared at the site of the fracture, and steadily increased in size.

NOTE.—I have later been over the case personally with Colonel Hawley, and he states there was no evidence of tumor in the first *x*-ray pictures at the time of the fracture.

He remained at St. Vincent's Hospital for twenty-seven weeks. The tumor steadily increased in size and on October 3 the patient was sent to the German Hospital, New York City, where he came under the care of Dr. Herman Fischer. On October 20 Doctor Fischer referred the patient as an inoperable sarcoma of femur to my service at the Memorial Hospital. He was examined at the clinical conference of the hospital staff and both Doctor Downes and I regarded the case as entirely beyond hip-joint amputation. At this time the

middle and upper portion of the left thigh measured 68 cm., and the right thigh 51 cm., and there was a complete pathological

FIG. 19.—(Case V.) Inoperable periosteal sarcoma of femur. Disappearance under large doses of toxins and radium. Treated at Memorial Hospital, October, 1917, to July, 1918. Picture taken on admission. Entire disappearance of tumor and patient well October 26, 1919. Two years.

fracture at the upper and middle third of femur. Longitudinally the tumor extended for a distance of 17 cm. The mixed

toxins were begun on October 30, and continued three or four times a week, alternating the systemic with local injections,

FIG. 20.—(Case V.) Inoperable periosteal sarcoma of the femur. Disappearance under large doses of toxins and radium. Treated at Memorial Hospital from October, 1917, to July, 1918. Picture taken one year after entering hospital, October, 1918.

and producing severe reactions. On November 5 and 6 he was treated with very large doses of radium, by means of a pack,

applied at 10 cm. distance, and remaining for a total of sixty-one hours (total dose, 40,000 mc. hours). An *x*-ray picture taken at the time of his admission to the Memorial Hospital showed complete destruction of the bone, involving the neck of the trochanter and upper 5 inches of the shaft. An *x*-ray picture of the chest showed "chronic diffuse bronchitis, both apices (cloudy plates) suggestive of tuberculosis—probably metastases from the tumor in the femur." By December 10 there had been a decrease of 4 cm. in the circumference of the thigh. The radium was again applied on December 25, 1919. Examination on April 8, 1918, showed a still further decrease in the circumference of the thigh. The toxins were kept up without further radium treatment. On June 23 the patient was sent home to Bridgeport, Connecticut, to remain there during the hot weather and return in the fall. At that time his general health was good; the tumor had decreased in circumference from 68 to 60 cm., with a corresponding decrease in the vertical dimension; there was still marked mobility at the site of the fracture. The leg was put in a Thomas splint. He received no treatment during the summer.

On October 8, 1918, the patient was readmitted to the hospital, at which time his general health was good, and clinical examination showed apparently complete disappearance of the tumor. The length of the left leg was 33 inches, and the right, $38\frac{1}{4}$ inches, showing a shortening of $5\frac{1}{4}$ inches. The circumference 5 inches below the trochanter, left side, was 21 inches, and the right, $23\frac{3}{4}$ inches. Circumference 5 inches above upper border of patella, left side, $19\frac{1}{2}$ inches; right, 20 inches. The patient had had no treatment since leaving the hospital in June. *X*-ray pictures taken at the time of his readmission showed apparently no tumor tissue left. The proximal portion of the femur at the site of the pathological fracture had been drawn upward to the region of the trochanter, and there was an attempt at union due to formation of new bone. *X*-ray examination of the chest was negative.

At the present time the patient is still wearing the Thomas

splint adjusted by Doctor Gibney. This patient was kept under frequent observation during the fall and winter of 1918–1919, and was shown before the American Surgical Association June 6, 1918. He is still wearing a Thomas splint, but the pathological fracture has united and is sufficiently firm to permit him to raise his leg without support. Recent *x*-ray photographs show no evidence of tumor and his general health is quite normal.

NOTE.—He was also shown at the Clinical Congress of Surgeons in New York October 23, 1919, two years after treatment.

CASE VI.—*Central Sarcoma of the Radius; Clinical and X-ray Diagnosis; Inoperable; Entire Disappearance Without Sacrifice of the Arm, Under Toxin Treatment Alone.* L. D. G., male, aged twenty-nine years, was referred to me by Dr. V. P. Gibney on April 25, 1918, with the following history:

Eight years ago had sprain of the wrist, but apparently completely recovered. In November, 1917, or five months prior to my first observation, he noticed sharp pain like the prick of a needle; two months later loss of power in hand; at the same time he noticed an enlargement of the lower portion of the left wrist, which enlargement increased rapidly. Physical examination showed enlargement of the lower portion of the left forearm, extending down to the wrist. The tumor was apparently primary in the radius, involving the lower 3 inches. The whole wrist was markedly enlarged, the circumference being 2½ inches greater than on the normal side; there was apparently some thickening of the ulna as well. There was a pathological fracture of the radius and almost complete fracture of the ulna as well. The skin was normal, not adherent; the tumor was soft, semi-fluctuating in consistency. The clinical diagnosis of sarcoma was made and confirmed by *x*-ray examination. The *x*-ray picture showed complete destruction of the radius over 2 inches; the tumor had apparently broken through the outer shell of bone and extended outward, involving the soft parts which were pushed to one side. On the left side the tumor extended beyond the ulna, which was apparently involved. The *x*-ray picture did not fully show the damage to the ulna, but the clinical examination showed almost complete pathological

fracture. Amputation had been advised and the patient was willing to sacrifice the arm, if necessary. He was admitted to the Hospital for Ruptured and Crippled on April 25, 1918, and

FIG. 21.—(Case VI.) Sarcoma of femur, *x*-ray taken one year after beginning treatment with toxins and radium. Entire disappearance of very large sarcoma involving upper two-thirds of femur under eight months' treatment of massive doses of radium, and large doses of mixed toxins injected systematically into tumor. Patient well October 26, 1918, two years later, with five and one-half inches of shortening. Note the original *x*-ray picture taken before treatment was too faint to make a good print. It showed a very large tumor, apparently of periosteal origin.

put upon the systemic injections of the mixed toxins of erysipelas and Bacillus prodigiosus. Only one injection was made directly into the tumor, $\frac{1}{8}$ minim. This was followed by a very severe

reaction, a temperature of 104°, nausea and vomiting and marked herpes of the lip. The systemic injections did not produce any marked chill or severe reaction until the dose had been increased up to 6 mm.

FIG. 22.—(Case VI.) Sarcoma of lower end of radius. Entire disappearance under toxin treatment alone in four months. Patient well at present, eighteen months later. See Fig. 19, taken seven months after treatment. Complete destruction lower three inches of radius. Rapid growth. Amputation advised by several surgeons.

At the time the toxins were begun the measurement over the most protuberant part of the tumor, 2 inches above the lower end of the radius, was $10\frac{1}{2}$ inches; normal side, 8 inches. I at

first intended to use both radium and the toxins in the hope of saving the limb. During the first two or three weeks of toxin treatment there was very little improvement, and in the early

FIG. 23.—Case VI.) Seven months after treatment. Entire disappearance of tumor under toxin alone. Patient now well with useful arm, eighteen months after beginning of treatment.

part of June, when I was out of town for a week, Dr. J. P. Hoguet came very near amputating the arm, believing that there was little or no hope of saving it by conservative treatment. The patient was quite willing to submit to the operation.

When on my return on June 10, there seemed to be appreciable improvement, we decided not to use any radium and the injections were kept up systemically, every other day, in doses sufficient to produce a temperature reaction of 102° to 104°. By the end of June the swelling had nearly disappeared,

FIG. 24.—(Case VI.) Sarcoma of radius before treatment. Cured by toxins alone. Patient well October 25, 1919. Toxins injected into buttocks systematically one year and four months. No other treatment.

and by the end of July it had entirely disappeared. The arm had been kept in splints during the early part of the treatment and later, after the tumor had disappeared, was kept in plaster of Paris with the hand in an abducted position, to avoid deform-

ity while the new bone was forming. The patient left the hospital and the treatment was kept up two or three times a week until the last of January, 1919. Frequent *x*-ray pictures were taken of the wrist, and these showed gradual increase in

FIG. 25.—Same case as Fig. 24, seven months after treatment. Splint removed and patient returned to work. Perfect function.

new bone taking the place of the 3 inches of radius and ulna which had been completely destroyed. The patient wore a short palmar splint for six months; the new bone which had replaced the lower end of the radius is not entirely solid yet, but I believe it will soon be completely restored and the arm will be quite

as useful as ever. I feel some confidence in this prognosis for the reason that in two similar cases in which the tumor had disappeared under the toxins without other treatment—both confirmed by microscopical examination—there has been complete restoration of the function of the respective limb; one of these patients is now well more than ten years.

NOTE (October 23, 1919).—The patient has been using his arm since January, 1919, and doing his regular work as a grocer. He has normal functions and little deformity. This patient was shown before the Clinical Congress of Surgeons October 23, 1919. The patient is still well, February 1, 1920.

The following case shows the difficulty sometimes experienced in determining in what cases to make use of conservative treatment and in what cases to amputate:

CASE VII.—*Sarcoma of the Radius and Ulna.* C. R., male, aged twenty-two years, was referred to me on September 22, 1914, with the following history: In May, 1913, he had first noticed a slight swelling in the lower end of the right radius; this was accompanied by pain which rapidly increased in severity. In September, 1913, the lower third of the radius was resected by Dr. Howard Lilienthal. The pathological examination of the tumor showed it to be a round-celled sarcoma with no giant cells. Four months later there was a return of the growth in the lower end of the ulna, with spontaneous fracture. Doctor Lilienthal then referred the patient to me for the toxin treatment. Physical examination at this time showed the lower half of the forearm enlarged, the skin purple in color; there was marked protuberance of the dorsal surface of the forearm extending down to the metacarpal bone. The swelling was soft, almost fluctuating, spontaneous fracture of the ulna, egg-shell-like crackling on palpation and some tenderness. The whole lower third of the ulna has apparently become disorganized and false motion is elicited almost at any point. There is marked silver-fork deformity of the wrist, and absence of the lower end of the radius. The *x*-ray taken on September 23, 1914, showed sarcoma of the radius with marked osteoporosis of postoperative

remnant of radius; spontaneous fracture of ulna, marked sarcomatous involvement of ulna with some attempt at periosteal proliferation. Diagnosis: Osteosarcoma. The patient went out on a pass before treatment was instituted, and failed to return until October 13, 1914. During this short interval of three weeks the tumor had increased very markedly in size; it had attained the size of a small fist, involving the lower part of the right forearm and extending up a distance of two-fifths on the ulnar side and two-fifths on the radial. He remained in the hospital until October 31, 1914, and received nine doses of the mixed toxins, ranging from $\frac{1}{6}$ to $2\frac{1}{2}$ mm., the highest temperature reached being 102.5°. The injections were made locally into the tumor. No marked change was noticeable from the treatment and the patient was referred back to Doctor Lilienthal for amputation, who operated upon him on November 2, doing a circular amputation of the humerus in its lower third. A little more than four weeks later, about the middle of December, the patient died of metastases of the lungs. A letter from Doctor Mandelbaum, who had again carefully gone over the sections in this case, states that there were found no giant cells in either specimen. The *x*-ray picture in this case closely resembles the picture of the preceding case that recovered under toxins alone.

CASE VIII.—*Sarcoma of the Fibula of Marked Malignancy, Trauma.* H. D., male, aged twenty years, referred to me by Dr. E. J. Mitchell, of Memphis, Tennessee, on April 18, 1918. The patient had been perfectly well until ten weeks ago, when, while wrestling at school, he sprained the right leg just below the knee. Two weeks later he began to have slight pain; a little later lameness developed, but no appreciable swelling, and frequent *x*-ray examinations showed nothing abnormal. About two weeks ago the patient was examined by Doctor Mitchell, who detected a slight swelling in the outer upper aspect of the right leg. An exploratory operation was performed by Doctor Mitchell on April 14, an incision $5\frac{1}{2}$ inches long being made over the fibula from the head downward, and a tumor was found involving the entire upper four inches of the fibula, extending

into the knee-joint. The report of the microscopic examination made by Doctor Kraus, of Memphis, reads: "Endothelioma with some areas of rapid growth, round-celled type and others of slower development with central mucoid; the proliferation around preformed spaces is typical." The wound was drained and the patient referred to me for advice and treatment.

Physical examination at this time showed a 6-inch cicatrix beginning over the upper end of the fibula and extending to the upper and outer aspects of the knee; the exploratory wound was packed with gauze and there remained a good sized rubber drainage tube. There was very little swelling of the knee or leg and but slight tenderness over the knee, apparently little effusion of the joint. An *x*-ray picture taken showed extensive involvement of the upper portion of the right fibula, also evidence of involvement of the knee-joint. The patient had lost 20 pounds in weight and motion of the joint was extremely painful. The patient was put upon the mixed toxins of erysipelas and Bacillus prodigiosus in doses to produce a slight chill. On April 21 the patient was given 6000 mc. hours of radium over the outer aspect of the tumor, and on April 25, a rubber tube containing 99 mc. of radium and four silver tubes were inserted into the sinus left from the exploratory operation covering the upper 4 inches of the fibula. It was left in place for six hours.

April 30: The tumor has steadily increased in size, in spite of the treatment; the effusion of the knee-joint is much more marked and there has been considerable swelling of the whole lower portion of the leg. At the site of the drainage tube in the upper portion of the wound there is beginning to appear a fungoid growth of tumor, bleeding very readily. The disease is progressing very rapidly in spite of the treatment and immediate amputation is advised.

The toxins were given systemically for a considerable period after amputation; about four months later metastases developed in the chest. The disease ran a very rapid course, causing death six months from the time of amputation.

As regards the advantages and disadvantages of resection, I personally have never employed resection and bone-implanta-

tion in any of my cases. The end-results in the group of cases shown before the American Surgical Association—(*a*) extensive sarcoma of lower end of femur, well four years and eight months; (*b*) extensive sarcoma of upper end of tibia, well three years and ten months—show that Nature unaided is able to restore large defects in the long bones if the tumor tissue has been destroyed. Also in these cases recent *x*-ray pictures taken show in one case almost complete restoration of 5 inches of the upper end of the tibia, and in the other case a very successful attempt to reconstruct the lower end of the femur with formation of a new condyle in place of the one destroyed. If we can cure the disease and keep the limb at rest for a long period of time in plaster of Paris, very satisfactory results can be obtained without resection. In the cases that have come under my observation in which resection of the upper end of the humerus was performed by other men, the results have been so unsatisfactory that I dislike to recommend this method of treatment. In one of these cases, rapid generalization of the disease prevented an opportunity to judge of the end-results as regards the usefulness of the arm, and in the other, now six months after operation, the arm is entirely useless. I doubt if it will ever have any functional value even if the disease is cured, which at present is doubtful.

Case IX.—*Sarcoma of the Humerus Treated by Resection.* E. D., male, aged twenty-eight years, always well until September, 1917, when he received a series of vaccinations preparatory to entering the army. All the vaccinations were given in the muscles in the upper part of the right arm. A few weeks later, he began to have soreness at the site of inoculations and also loss of function of the arm. A swelling appeared and slowly increased in size until January, 1919, when he was operated upon by Doctor Hitzrot at the New York Hospital. A portion of the humerus was resected and grafts from the tibia implanted. On February 28, 1919, Doctor Hitzrot referred the patient to the Memorial Hospital for radium treatment. From that time up to the present, he has had a total of 75,000 mc. given on various occasions, varying from 9000 to 40,000 in a single application. The treatment has been given by Doctor Janeway.

X-ray examination shows the absence of $3\frac{1}{2}$ inches of the right humerus. The pathological diagnosis made at the New York Hospital reads as follows: "Osteochondrosarcoma; diffuse, infiltrating growth, involving the entire bone, extending into the surrounding muscle and fascia; extensive infiltration of muscle tissue. Diagnosis: osteogenetic sarcoma." *X*-ray examination of the chest shows considerable infiltration about the right hilum, extending up into the apex; no definite glands.

July 1, 1919: The patient is still under treatment. A recent *x*-ray picture taken failed to show any evidence of a tumor either in the bone or soft parts, and chest examination is negative. It is too early to regard the disease as under control, but it is almost certain that the arm will be of little use, even if the patient is cured of the sarcoma.

The following case of periosteal sarcoma of the humerus is interesting from the fact that there are few recorded cases in which the patient has been well over three years. Of 54 cases of sarcoma personally observed, only 2 are known to be well beyond three years.

Case X.—Mr. L., aged thirty-five years, was referred to me by Dr. J. M. T. Finney, of Baltimore, nine years ago, June, 1910. The tumor developed within two weeks after a spiral fracture of the humerus, and Doctor Finney believed that amputation offered no hope of saving the patient's life. In this case a large, rapidly growing tumor apparently disappeared under the toxin treatment alone; six months later it recurred and I performed a shoulder-joint amputation. This operation was followed by a very large recurrence in the pectoral muscle, which was only partially removed, and then prolonged toxin treatment given. The disease finally disappeared and the patient is now in good health, eight years later. A microscopic examination had been made by Doctor Bloodgood and also by Doctor Ewing; both pronounced it a highly malignant spindle- and round-celled sarcoma; no giant cells.

Note.—In October, 1919, I learned the patient had just died of lung metastasis. This leaves but one patient in my earlier series of 54 cases permanently cured of sarcoma of humerus.

This case has already been reported in full in the *Annals of Surgery*.

The following history illustrates the difficulties often associated with the early diagnosis of malignant tumors of the long bones. It plainly shows that in some cases it is practically impossible to make an early diagnosis, even with the aid of the *x*-ray and exploratory operation and microscopic section.

CASE XI.—*Spindle-celled Sarcoma of the Radius with Metastases.* W. T., aged twenty-six years, referred to me by Dr. David Felderbaum on March 26, 1919, with the following history: The patient, a college man, has always been very active in athletics; played much foot-ball, but does not remember any particular injury to the arm. Two years ago he first noticed what was believed to be rheumatic pain in the left arm, but there was absolutely no swelling. Three months later he had another severe attack of local pain, without swelling; physician could feel no tumor whatever. The first *x*-ray was taken in September, 1917, and showed the condition to be probably osteomyelitis. First operation in October, 1917, at the Mt. Sinai Hospital, by Dr. Alexis Moschcowitz. An incision was made and the bone scraped. The tissues removed were examined by Doctor Mandlebaum, who reported "no evidence of sarcoma." A month later the pain returned and Doctor Moschcowitz, suspecting sarcoma, again operated. At this time pathologic examination of the tissues removed showed sarcoma of the small spindle-celled type. In March, 1918, a third operation was performed by Doctor Moschcowitz, who resected the upper half of the radius. The pathological examination again showed small spindle-celled sarcoma. The patient remained perfectly well until November, 1918, one and one-half years later, when he began to feel pain in the right hip. A few weeks later a soft swelling developed over the occipital protuberance; this has been increasing in size steadily up to the present time (March, 1919). He also has had severe pains in the lower side of the right thorax, accompanied by some cough, but without loss of weight. The *x*-ray pictures revealed a large

spherical mass replacing the entire root of the left lung and small numerous masses in the lower part of the right lung, apparently mainly pleural. There is a small amount of fluid in the right chest and numerous small nodules along the root of the lung. The picture of the skull shows a cystic condition eroding the occipital bone. The patient was referred to me for radium and toxin treatment. In view of the advanced condition of the disease and the marked generalization, it was decided to try the effect of intravenous injections of the active deposit of radium, together with a radium pack over the tumor of the skull. There was considerable decrease in the size of the tumor of the skull, and slight improvement in general condition. At the present time the pain is returning and the tumors are increasing in size and generalization of lesion progressing.

End-results in a Series of 250 Cases of Sarcoma of the Long Bones Observed from 1890 to 1919. The serious and almost hopeless prognosis of sarcoma of the long bones from a surgical standpoint was well brought out at a symposium on Sarcoma of the Long Bones before the Royal Society of Medicine in London, November, 1912. Of a series of 61 cases observed at St. Bartholomew's Hospital during the preceding ten years, all were treated by amputation with the following results:

Of 25 cases of periosteal sarcoma of the femur not a single patient was alive over three years later; of the myeloid type, 4 in number, only 2 survived the three-year period. Of 8 humerus cases, not a single patient reached the three-year limit. Of 2 radius cases, 1 died and 1 remained well over three years. Of 11 periosteal sarcomas of the tibia, 1 remained well over three years, and of 3 of myeloid type, 1 remained well over three years. Of 61 cases of sarcoma of the long bones only 5 were well over the three-year period.

The statistics of St. Thomas's Hospital, covering the same period, show 28 periosteal cases and 17 myeloid. Of the former, not a single patient remained well over three years; and of the latter, only 5 (all of the giant-celled type) remained well for that length of time.

It is worthy of note that conservative treatment was not employed in any one of these cases, all having been treated by amputation.

Personal Cases. An analysis of cases personally observed from 1890 to 1919 shows:

Femur	114
Humerus	53
Tibia	40
Fibula	9
Radius	12
Ulna	8
Clavicle	11
Metacarpal	2
Metatarsal	1
Total	250

Of 114 femur cases, 18 were alive and well over three years. Of these amputation was performed in 15 cases, preceded or followed by a course of toxin treatment, and in no less than 6 cases the limb was saved by conservative treatment. Of these 6 cases, 3 were of the periosteal type and 3 central mixed, giant- and spindle-celled.

Case I.—A small round-celled periosteal sarcoma involving two-thirds of the shaft of the femur, with extensive metastases in the ilium. Patient was treated with *x*-rays in February, 1902, for the tumor of the femur. Later a very large metastatic tumor developed in the ilium and was treated with toxins alone. The disease entirely disappeared and he remained well for ten years, and then died of carcinoma, which developed in an old *x*-ray burn of the thigh.

Case II.—Extensive periosteal sarcoma of the femur, clinical and *x*-ray diagnosis. Amputation advised by several surgeons, but refused. Treated with toxins alone. Well eight years.

Case III.—Extensive periosteal sarcoma of the femur, small round-celled (no giant cells); diagnosis confirmed by microscopic examinations at the State Laboratory of North Dakota. Case pronounced beyond hip-joint amputation by Dr. Wm. J. Mayo.

Toxins advised and carried out by Doctor Williamson, of North Dakota. Limb saved, patient in good health ten years later.

CASE IV.—Extensive central sarcoma of the upper portion of the femur, pronounced inoperable by Dr. A. P. Gerster. Diagnosis (giant-celled sarcoma) confirmed by microscopic examination. Pathological fracture; curetting, followed by toxins; complete recovery, reunion of bone, useful limb. Patient well when last observed eight years later.

CASE V.—Central sarcoma of the femur, with extensive involvement of the knee-joint, believed to be too far advanced for conservative treatment and amputation recommended by Doctor Gibney and myself, but refused by patient. Entire disappearance of the disease under toxins alone, and patient well at present with a useful limb four years and nine months later. Giant and spindle-cell sarcoma.

CASE VI.—Sarcoma of lower end of femur, with extensive involvement of knee-joint and upper end of tibia. Amputation advised by several surgeons, including myself, as the condition was regarded too far advanced for conservative treatment. Complete recovery under curetting and long continued toxin treatment, supplemented at the end of two months by radium in the form of a pack, and 100 mc. of radium emanations introduced into the sinus in a steel needle. Patient well and walking about with scarcely any limp three years later.

Another case of periosteal round-celled sarcoma of the femur successfully treated with the toxins by Doctor Runyan, of Little Rock, Ark., under my direction might be included. An exploratory operation was made in February, 1913; microscopic examination, small round-celled osteosarcoma; complete disappearance under four months' toxin treatment; patient in good health, with a useful limb four years later.

Of 40 tibia cases, 8 were known to be well for a period of more than three years after operation. Of these cases amputation was performed in 4, and in 4 the limb was saved. The cases in which amputation was done, are as follows:

CASE I.—Giant-celled sarcoma of tibia; amputation of the thigh; patient remained well for seven years and then died of lung metastases.

CASE II.—Central sarcoma of upper end of tibia; amputation alone; patient well ten years.

CASES III and IV.—Both periosteal sarcomas well over three years; amputation, followed by toxins as a prophylactic.

CASE V.—Periosteal sarcoma of tibia; well five years after amputation; then died of metastases of skull.

The 4 cases in which the limb was saved are as follows:

CASE I.—Periosteal spindle-celled sarcoma of tibia; entire disappearance under toxins; patient well at present, twenty years.

CASE II.—Central sarcoma of upper end of tibia; mixed-celled (round-, spindle- and giant-celled); disappearance under toxins; patient well eight years.

CASE II.—Mixed-celled sarcoma (spindle and giant cells) of upper end of tibia; twice recurrent; disappearance under toxins and radium; patient well four years later.

CASE IV.—Sarcoma of lower end of tibia. Giant-celled and spindle-celled. Three times recurrent. Disappeared under toxins and *x*-ray, 1905. Well at present, fourteen years.

Sarcoma of the humerus has long been regarded as the most malignant of all types of tumors of the long bones, and my own series of cases supports this view. Of 53 cases of sarcoma of the humerus, only 2 survived the three-year period, and both of these cases can reasonably be regarded as cures.

NOTE.—In one of my cases (see page 325), which I believed to be a case of sarcoma of the humerus, I have just learned the patient died a few weeks ago of metastasis, more than nine years after treatment.

In the other cases the patients have all died with the exception of 2, who are under treatment at present with a moderate chance of getting control of the disease. In the 2 successful cases, 1 was a sarcoma of the upper end of the humerus, involving the glenoid portion of scapula; exploratory operation done by Dr. J. Bapst Blake. The disease was found to be quite inop-

erable, too far advanced for shoulder-joint amputation. The toxin treatment was carried out under my direction. The tumor entirely disappeared and the woman completely regained the use of her arm, and remained well for twelve years, when she died from some independent trouble. The diagnosis was round-celled sarcoma.

NOTE.—Doctor Bloodgood says he has never seen a giant-celled tumor of the humerus.

CASE II.—A very malignant periosteal, round- and spindle-celled sarcoma, no giant cells, starting in the middle of the humerus, following a recent fracture. The tumor apparently disappeared under toxins alone; pathological fracture reunited; recurrence in the head of the humerus six months later; amputation; large recurrent mass in the pectoral region; incomplete removal followed by toxins; final recovery; well eight years.

NOTE.—While the article was in press, I have learned this patient was just dead of metastases of lung.

Of 12 cases of sarcoma of the radius, 6 remained well beyond the three-year period. They are as follows:

CASE I.—Large giant-celled tumor of the radius, treated by another surgeon by simple curetting; observed by myself; perfectly well eight years later.

CASE II.—Extensive sarcoma of the radius, involving the ulna; amputation, followed by toxin treatment; well ten years.

CASE III.—Giant-celled sarcoma of lower end of radius; curetting by Doctor Hartley; amputation advised but refused; complete recovery under toxins; patient well eleven years.

CASE IV.—Giant-celled sarcoma of lower end of radius; small portion removed for microscopic examination; no curetting; disappearance under toxins alone; well three years later.

CASE V.—Periosteal spindle-celled amputation followed by toxins; well three and one-half years.

CASE VI.—Extensive sarcoma of lower end of radius, with involvement of the ulna. Clinical and *x*-ray findings permitted no doubt as to the correctness of the diagnosis; amputation

advised by several surgeons but refused; complete disappearance under toxins alone in May, 1918. Patient well at present with a useful arm.

This may have been a giant-celled tumor, although the bony shell has been destroyed, and the tumor was of open growth.

Of the 8 ulna cases, 1 spindle-celled sarcoma in which amputation was done remained well for seven years and then died of abdominal metastases.

Of the 9 cases of sarcoma of the fibula, not a single patient is known to have remained well beyond the three-year period.

Of the 11 cases of sarcoma of the clavicle, a total excision was done in 3, followed by the use of the toxins. This group is as follows:

Case I.—Sarcoma of clavicle; total excision three weeks after noticing a rapidly growing tumor, which followed immediately after an injury; toxins given; local and metastatic recurrences within three months; death shortly after; whole course of disease was less than five months.

Case II.—Total excision of clavicle for a rapidly growing periosteal sarcoma (round-celled, no giant-celled), followed by a long period of toxin treatment; patient in good health at the present time, with perfect use of arm, nine years later. Radium and toxins used in 2 inoperable cases, with only temporary benefit.

Case III.—Total excision of clavicle for a round-celled sarcoma, periosteal, which Dr. Maurice Richardson referred to me for toxin treatment as a prophylactic. Toxins given for six months; patient in good health nine years later.

These cases are of particular interest inasmuch as the high malignancy of sarcoma of the clavicle is well known, there being few cases of cure on record—except the Valentine Mott case, in which the diagnosis is now believed to be "chondroma" instead of "sarcoma."

A brief summary of the cases that have remained well over the three-year period:

Patients remaining well more than three years, 31. Of these

the disease recurred and proved fatal after three years in 5 cases. One tibia, seven years; 1 ulna, seven years; 1 humerus, five years; 1 tibia, five years; 1 femur, 5 years.

TYPE OF TUMOR IN CASES WELL OVER THREE YEARS

	PERIOSTEAL
Femur	8
Clavicle	2
Radius	1
Ulna	1
Humerus	1
Tibia	1
Metatarsal	1
Total	15

There were no giant-celled tumors in this series of cases. One case was pronounced a chondroma at the time of the first operation (hip-joint amputation performed by another surgeon); he remained well for five years, after which the disease recurred locally; I performed a second extensive operation, followed by a course of toxin treatment; the disease recurred again three years later, involving the pelvic bones; condition inoperable; failed to respond to large doses of radium; hopeless when last seen. This case proved to be a chondrosarcoma.

One patient with a spindle-celled sarcoma of the ulna remained well for seven years after amputation, and then developed an inoperable abdominal recurrence, causing death in less than a year. Another case, a periosteal ossifying sarcoma treated by amputation, later followed by toxins, remained well for about three years and then died of metastases.

In this series of cases the diagnosis was confirmed by microscopic examination, with the exception of one case, and in this, the rapid growth of the tumor in a young adult, combined with the very definite evidence of the *x*-ray picture, left little doubt as to the correctness of the diagnosis. The tumor disappeared under the toxins and the patient remained well for seven years.

In this group of periosteal tumors, amputation was performed

in 9 cases, followed by toxins in 7. (For a more detailed history, see the preceding notes.)

CENTRAL

Femur	7
Tibia	5
Radius	3
Humerus	1
Total	16

Cases in Which the Limb was Saved. In this series of cases it has been found possible to save the limb in 17 cases; 11 by the use of the toxins alone; 4 by a combination of toxin and radium treatment; 2 by curetting (the latter 2 were giant-celled sarcomas, or giant-celled tumors). Of the 17 cases in which the limb was saved, 6 were of periosteal origin and 12 of central origin. Fourteen have remained well more than three years.

A detailed study of the pathological diagnosis in this series of cases of sarcoma of the long bones, together with the question of the prognosis based upon the histological structure, will form the basis of a subsequent paper.

DISCUSSION

Dr. Harvey G. Mudd, St. Louis:

Although it has no connection with sarcoma of the long bones I have been asked to report one case of sarcoma of the ovary in which the toxins gave permanent benefit. It was the case of a young woman from whom I removed a sarcoma of the ovary. Before the healing of the abdominal wound took place another tumor had formed in the abdominal wall. Coley's toxins were administered and the mass in the abdominal wall disappeared and the patient remains well up to this time. The operation was made July 18, 1907. I report this as merely one more cure of a frightfully malignant condition by Coley's toxins. Microscopic examination confirmed the clinical diagnosis of sarcoma.

Dr. Howard Lilienthal, New York:

I have had no luck in using Coley's toxins in sarcoma of the long bones, excepting after operation. In tumors in other locations I have been more fortunate, but shall, of course, continue to use them in all inoperable cases.

Dr. Miles F. Porter, Fort Wayne:

I had a case of sarcoma of the radius in which I attempted conservative treatment, because of recurrence, but later did an amputation. The patient remains well more than eight years after the operation.

Dr. George W. Crile, Cleveland:

I should like to ask whether any surgeon present has ever cured a case of sarcoma by Coley's toxins or has ever had a permanent cure by amputation?

Dr. Howard Lilienthal, New York (replying to Dr. Crile):

I can report one case which Dr. Coley has in his record, the cure of an inoperable (?) case of sarcoma of the tibia by amputation sixteen or seventeen years ago. I saw the patient a few years ago and she is still perfectly well. Amputation was done through the lower third of the femur. I am a firm believer in the use of Coley's toxins; in fact, I think I was the first to consider using the remedy as a prophylactic following operation.

Dr. Frank E. Bunts, Cleveland:

I have one case to report in which I thought to remove a sarcoma by resection of about six inches of the femur. There was a recurrence and I did a hip-joint amputation. This was twelve years ago, and there has been no return.

Dr. John H. Gibbon:

I have had only one success in the use of Coley's toxins: a periosteal sarcoma and recurrence after ten years. The patient shown today by Dr. Coley is not only a patient but an intimate friend, and I turned him over to Dr. Coley. There was a recurrence in the glands later, yet the man is apparently well. This supports my faith in the use of the toxins in sarcoma whether the case is operated upon or not.

Dr. Ernest A. Codman, Boston:

I should like to ask Dr. Coley concerning the relative amount of good accomplished by the radium used with his toxins in these cases. I think he said that in only two of his cases were the toxins alone used.

Dr. Coley (in closing):

If I had had time to read my entire paper the questions asked would have been answered. I have had under my personal observation altogether 250 cases of sarcoma of the long bones; 200 of these were published in my paper read before the meeting of the Southern Surgical Association in December, 1917. Since that date I have observed 50 additional cases. Of these 15 are alive and well at the present time. In 3 or 4 the treatment has been so recent that it is impossible to tell what the final result will be. In 3 of these cases the limb as well as the life was apparently saved by conservative treatment. Of the total series 31 cases have remained well beyond the three-year period. The leg as well as the life was saved in 16 cases; in 11 cases by the toxins alone, in 5 by the use of the toxins in conjunction with radium or *x*-ray (4 toxins + radium and 1 toxin + *x*-ray).

I believe we have an additional chance of saving the limb as well as the life by combining the local effects of the radium with the systemic effects of the toxins.

A good deal has been written on the subject of the conservative treatment of sarcoma of the long bones, but I do not believe there is one member out of ten who would not have recommended amputation in any of the 4 cases shown before this Association.

THE ORGANIZATION AND OPERATION OF AN EVACUATION HOSPITAL

By DEAN LEWIS, M.D.
CHICAGO

AND

THOMAS J. LEARY, M.D.
BALTIMORE

During the war ideas changed from time to time regarding the organization of an evacuation hospital and the function which it should perform. The necessity of treating wounds early and of performing major surgical operations in the advanced zone demanded a larger staff than had been provided in the tables of organization. With the reintroduction of débridement into military surgery the evacuation hospital became the most active and important operating center in the whole chain of hospitals.

Changes in the physical equipment of the evacuation hospital were necessitated by the change from trench to mobile welfare. An evacuation hospital must be an actively mobile unit. In order not to embarrass transportation, which is not often available to the extent necessary, such a hospital should be under tentage. The bed capacity should not be greater than 500—425 Gold Medal cots and 75 iron beds for fracture cases. Beds are not needed so much as a force of operating surgeons large enough to take care of the wounded and a transport system which can provide for rapid evacuation.

The so-called evacuation hospital of trench warfare was not, strictly speaking, an evacuation hospital, for it was immobile,

and in many instances where it could have been moved the time required in taking it down and setting it up was so great and the amount of transportation needed to move it so large that it was for all practical purposes immobile. A hospital which by dint of circumstances is so situated that it receives wounded early but is immobile should be designated as an advanced base rather than as an evacuation hospital.

An evacuation hospital of 500 beds can take care of the wounded of a division providing it has ten operating teams and can evacuate the wounded frequently enough to provide beds for those being brought in. A hospital of this type must be easily moved. It should be taken down within twelve hours and be set up and receiving wounded in from eight to twelve hours after reaching the site selected for it. A water supply must be at hand and transportation provided before such a hospital can function. These are the two prime requirements.

A hospital of this type should be under tentage in order to permit of quick movement and to reduce to a minimum the demands upon the transportation system. Such a hospital is much more compact than a barracks hospital, regardless of how well planned such a hospital may be and how easily the different parts may be knocked down and put together.

The operating part of an evacuation hospital, such as the one now being described, should consist of five Bessonneau, Henri or Dickson tents. There should be twenty ward tents for housing the sick and wounded, one shock tent and one tent for the dressing of lightly wounded. In setting up the tents the idea of reducing to a minimum the amount of littering and of placing the patients being received so that they are operated upon in the order in which they are received, excepting of course, those which have been so seriously wounded that immediate care is necessary, should always be kept in mind. What we may designate as a linear set-up meets the requirements better than any other arrangement we know of.

Advantage of Linear Set-up. In this set-up, the receiving tent is placed upon the main road or not far from the same.

Directly back of this is placed the second tent in which bandages are changed; smaller dressings applied to facilitate the location of foreign bodies by *x*-ray examination; and antitetanic serum administered if none has been given previously.

The third tent is devoted to *x*-ray work. An evacuation hospital should always be provided with two *x*-ray machines in order that the operating teams should never be delayed because the wounded have had no *x*-ray examination.

Directly back of the *x*-ray tent is the pre-operative tent or ward provided with litter rests. The litters with the wounded are placed upon these rests in the order in which they enter the hospital, with the exception of the seriously wounded, who are taken care of immediately. Back of the preoperative ward is the operating tent.[1]

A small room built of wood should be placed at the middle of the side of the operating tent. All sterilizing should be done in this. No open flame should be allowed in the operating tent proper. A wall tent should be set up at the other end of this room, with which it communicates, in which supplies may be prepared and stored.

Two to three tents are reserved, as occasion demands, for non-evacuable cases. These tents are placed directly back of the operating tent and near the evacuation platform. In the same row as these are placed three tents for fracture cases.

[1] The advantage of this set-up is that there is a continuous litter from the receiving to the operating tent. It is practically impossible to lose track of the wounded, each being taken care of in the order in which he enters. By this arrangement there is no possibility of a wounded man being forgotten or disregarded for forty-eight hours or more, for he is always under the observation of litter bearers, who feed the operating room and besides these cases are checked frequently by the surgical chief or one of his assistants. This arrangement permits the surgical chief to operate and besides enables him to maintain supervision of the pre-operative ward because of its proximity to the operating tent.

On either side of the receiving ward are placed the shock and dressing tents. The sorting of cases is done in the receiving tent. The lightly wounded which only require dressing are passed out of the back of the receiving to the dressing tent and the badly shocked are taken directly from the receiving to the shock tent. Littering of shock cases is thus reduced to the minimum.

These tents are provided with iron beds. All the remaining tents are provided with Gold Medal cots. Seventy-five beds will usually accommodate all the fractures occurring when a division is in action, providing, of course, that the cases can be evacuated when necessary.

The remaining fourteen or fifteen tents are placed in two rows on one side of the row of tents belonging to the operating suite. The tents nearest the receiving ward are reserved for medical and eye and ear cases, and the walking wounded, requiring shelter. The tents in the middle are reserved for the less severely wounded.

The tent devoted to pathology is placed near the rear and close by the operating tent, in order that the pathologist or bacteriologist may be close at hand when a bacteriological examination of a wound is required.

The arrangement of the tents devoted to the administrative staff, to the officers, nurses and enlisted personnel and the quartermaster is demonstrated by the accompanying illustrations. The arrangement of the kitchen and mess tents is also shown.

The arrangement of the tents should be as compact as possible as the physical demands upon the personnel should be reduced to a minimum. Compactness adds to efficiency.

The following permanently attached personnel is required to run an evacuation hospital of 500 beds with ten operating tables. During active periods this staff should be reinforced by eight operating teams and a shock team. The teams headed by the surgical chief and his assistant should be permanently attached. The permanent personnel should consist of thirty officers. These include a commanding officer, an adjutant, quartermaster, a surgical chief with two assistants, an assistant chief with two assistants, an oculist, a dentist, four *x*-ray men, a pathologist and fourteen ward surgeons. The assignments should be somewhat elastic. At times, a surgical team may be reduced by one and the man may be assigned to work with more urgent demands, a nurse or an enlisted man acting temporarily in his place.

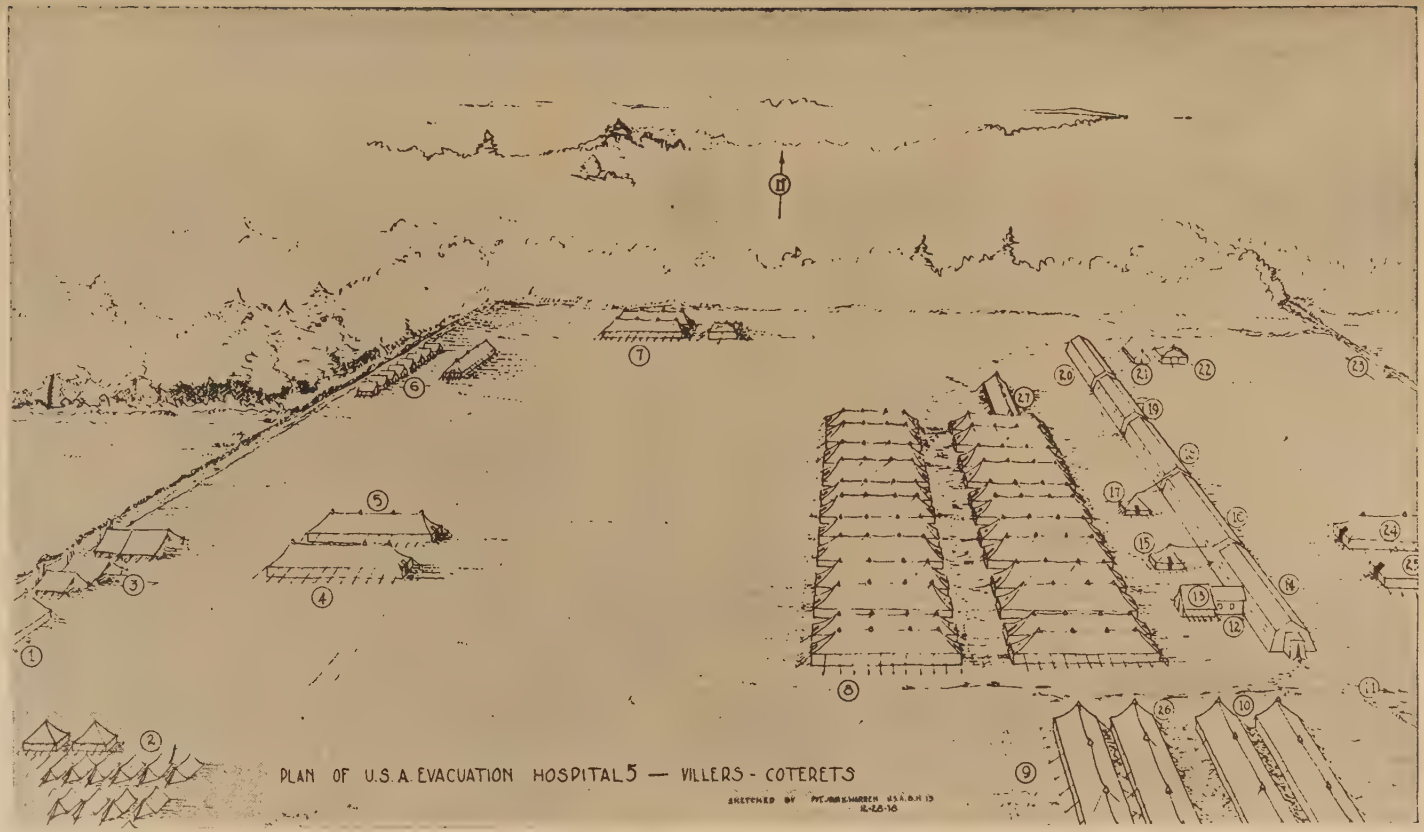


FIG. 1.—Plan of Evacuation Hospital No. 5, Villers-Coterets, France, August 29—September 14, 1918. 1, commissary; 2, personnel quarters; 3, kitchens; 4, nurses' mess; 5, officers' mess; 6, officers' quarters; 7, nurses' quarters and recreation tent; 8, surgical wards; 9, non-evacuable wards; 10 and 26, fracture wards; 11, road to evacuation platform; 12, sterilizing room; 13, dressing tent; 14, operating Bessonneau tent; 15, lighting plant; 16, pre-operative Bessonneau tent; 17, *x*-ray power plant; 18, *x*-ray Bessonneau tent; 19, 20, receiving wards; 21, headquarters; 22, Red Cross; 23, main highway; 24, quartermaster; 25, medical supplies; 27, shock ward.

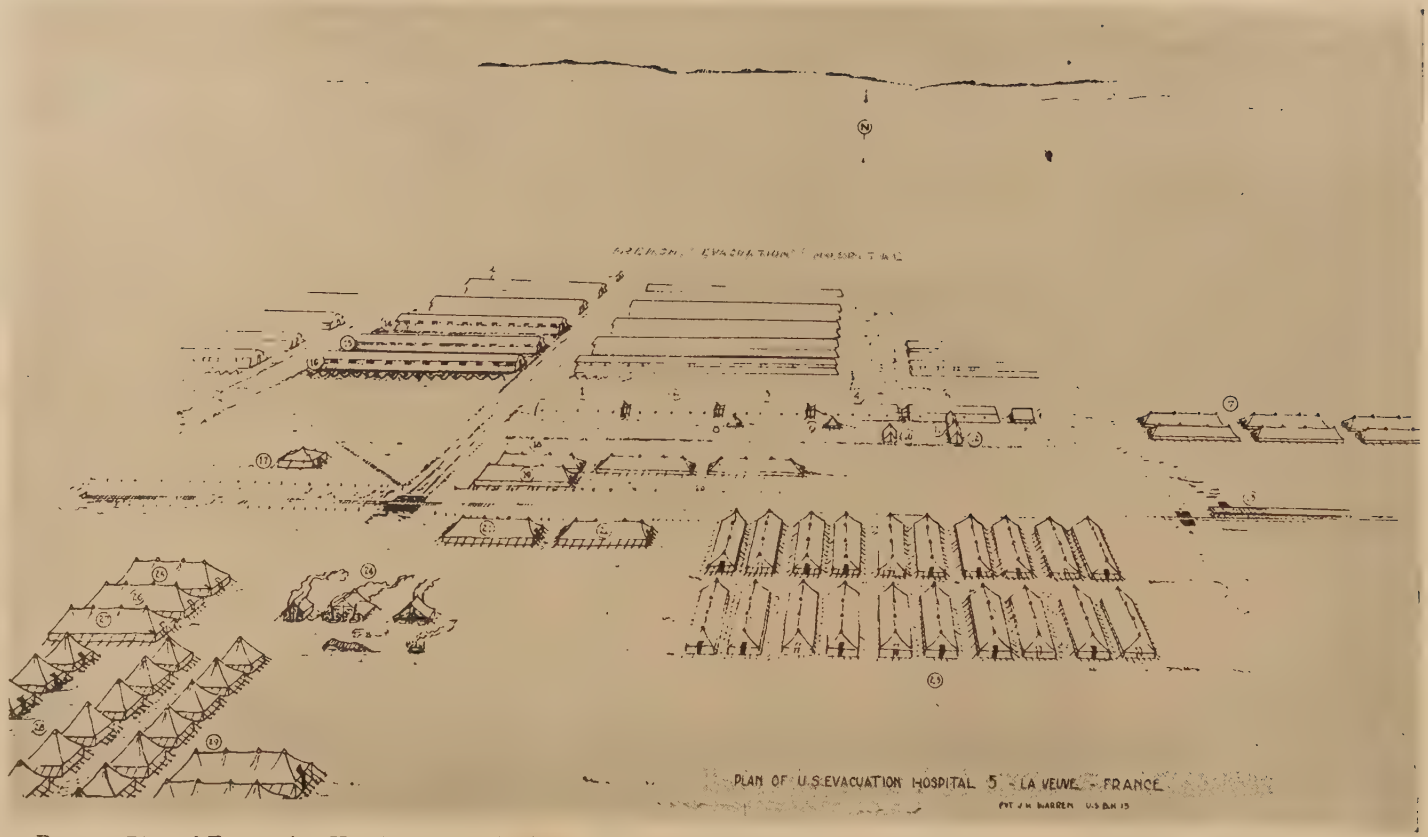


FIG. 2.—Plan of Evacuation Hospital No. 5, LaVeuve, France, September 30—October 20, 1918. 1, 2, receiving wards; 3, *x*-ray wards; 4, pre-operative ward; 5, operating room; 6, laboratory; 7 and 23, general wards; 8, *x*-ray power plant; 9, lighting plant; 10, dentist; 11, sterilizing room; 12, dressing tent; 13, evacuation platform; 14, officers' quarters; 15, nurses' quarters; 16, company officers; 17, Red Cross tent; 18, shock ward; 19, dressing tent; 20, non-evacuable ward; 21, quartermaster; 22, medical supply; 24, kitchens; 25, officers' mess; 26, nurses' mess; 27, commissary; 28, 29, personnel quarters.

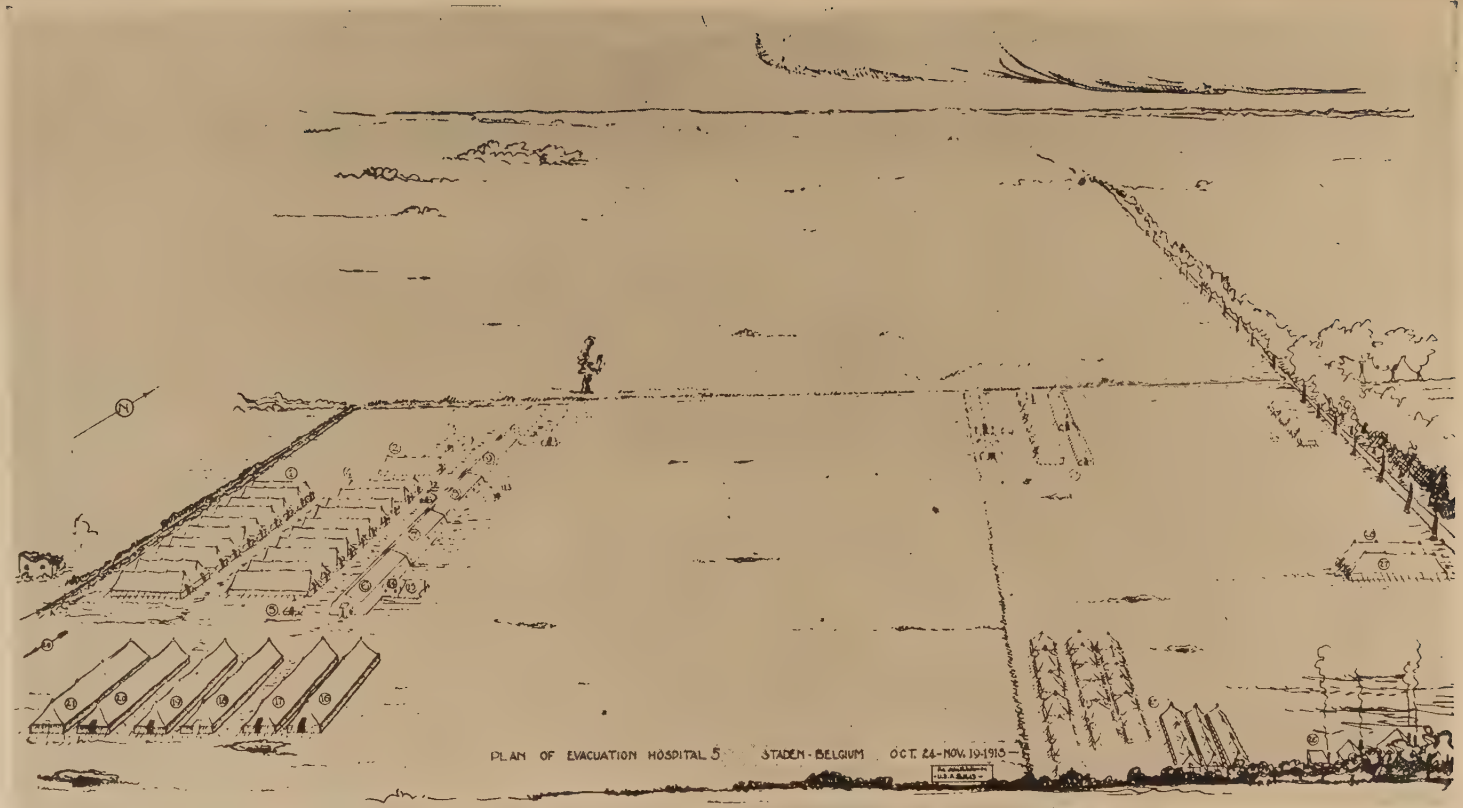


Fig. 3.—Plan of Evacuation Hospital No. 5, Staden, Belgium, October 24—November 19, 1918. 1, 4, 16, 17, 18, wards; 2, shock ward; 3, Red Cross tent; 5, patients' effects office; 6, operating room, Bessonneau tent; 7, pre-operative, Bessonneau tent; 8, *x*-ray; 9, 10, receiving wards; 11, dressing tent; 12, *x*-ray power-plant; 13, lighting plant; 14, sterilizing room; 15, surgical supply tent; 19, 20, 21, fracture wards; 22, nurses' quarters; 23, 24, officers' quarters; 25, personnel quarters; 26, kitchens; 27, quartermaster; 28, medical supplies; 29, road to evacuating platform.

Physicians especially trained should not be sacrificed to duties which men without special training may do as well, often better.

Two medical officers specially trained in sorting cases should be assigned to the receiving ward. These officers should work twelve-hour shifts. The sorting of the wounded is especially important. The wounded which can be dressed and sent back to the base form a relatively large proportion of those received. No case about which there is doubt should be sent to the dressing tent and no wound caused by high explosive should be sent out without an *x*-ray examination unless there is no doubt that the fragment of high explosive has not penetrated.

Triage work well done relieves the operating surgeon of much labor and reduces the amount of work which must be done in the operating room. Thus relieved, the surgeon can give more attention and render better service to those who need it.

Two medical officers should be assigned to the tent in which dressings are removed and reapplied, antitetanic serum given and morphin administered, when necessary. These officers should each work twelve-hour shifts. They will often have time during the less active periods to work in other parts of the hospital.

X-ray Teams. Accurate localization of foreign bodies is a *sine qua non* of success in evacuation hospital work. It saves unnecessary, often mutilating, operations. At least three, preferably four, *x*-ray men should be assigned to each evacuation hospital to operate the two machines with which each hospital should be provided. This is tedious, wearing work and a man does not work at maximum efficiency much over six hours. If the wounded are not rayed rapidly enough the work of the operating room is necessarily slowed down. There always should be in the preoperative tent at least twenty wounded who have been rayed, and the foreign bodies localized. Much time is lost and the general efficiency of the hospital is greatly impaired if at any time operating tables are empty and the surgical team unemployed, because obliged to wait for *x*-ray examination of the wounded. The work is heavy in all active periods. In

one offensive in which the hospital with which we were connected participated the *x*-ray men made 1068 localizations in seventy-two working hours.

It will not be necessary to have an officer detailed to the preoperative ward; a nurse and two enlisted men should be on duty to see that the wants of the men in the ward are attended to.

Surgical Chief, Assistant Surgical Chief and Operating Teams. Ten operating tables can be easily placed in a Bessonneau tent, which makes the best operating room. Ten teams should be provided in active periods, eight teams being detailed to the hospital when an active period is expected. Better work can be done, if enough teams are available, when they are more or less permanently attached to the hospital.

The surgical chief and his assistant should be experienced operating surgeons and each should take an active part in the operative work. They should take charge of the two tables in the center of the tent (five and six, if the tables are numbered from the entrance of the tent. The chief and his assistant should each work a twelve-hour shift. Working in this way a surgical chief has first hand knowledge of the character of the work that is being done; can keep track of those operated upon, thus determining which cases are evacuable and which are non-evacuable, and can act as a consultant. In military, as in civil surgery, the best consultant is the active, operating surgeon. As soon as a surgeon ceases to operate and becomes a directing or administrative officer his value as a consultant ceases. The operating surgeon, as a rule, will not value highly the opinion of a man who is not actively engaged in surgical work. There will frequently occur, during a shift, relatively inactive periods in which the chief of the surgical service can visit the receiving, preoperative and shock wards. He can gain in this way a rather intimate knowledge of what is transpiring in the hospital.

Surgical Teams. A surgical team should be composed of seven: three doctors, two nurses and two enlisted men. Such a team can do comfortably the work demanded of them. A sur-

gical team of six: two doctors, two nurses, one anesthetist and one enlisted man can do the work easily.

The operative work is necessarily arduous, and the arrangements should be such that a team can do the maximum of work with the minimum of effort. Their time should be conserved. A time schedule should be put in operation, which does not permit of more than eight consecutive hours of work, and provision should be made, so that the team can get a full night's sleep at least every other night. It is absolutely necessary to conserve the energies of the personnel.

An operating team should take charge of two tables. While one operation is being performed the wounded man on the other table should be prepared. There should be such coöperation between the preoperative and operating tent that an operating table is never empty. One of the commonest causes of loss of time and reduction in the amount of operative work performed during the day in an evacuation hospital is the lack of coördination between the preoperative and operating tent. A table empty for a short while means a marked reduction of the amount of work done during the twenty-three hours that the operating room is active.

The following time schedule, which was operative in Evacuation Hospital No. 5, proved to be very satisfactory. After being posted the officer knew the hours at which his team was supposed to report, and no further notification was needed.

A surgical team on this schedule does not work over eight hours consecutively, and sleeps every other night. The following schedule became operative October 29, 1918, in Staden, Belgium.

	8 A.M. to 4 P.M.	4 P.M. to 12 M.	12 M. to 7 A.M.
Tables 1 and 2	Major Bailey	Lt.-Col. Elting	Major Bailey.
Tables 3 and 4	Major Stewart	Major Drennan	Major Stewart.
Tables 5 and 6	Lt.-Col. Lewis	Capt. Noble	Lt.-Col. Lewis.
Tables 7 and 8	Major Kocyan	Capt. Zimmerman	Major Kocyan.
Tables 9 and 10	Major Long	Major Ransohoff	Major Long.
	October 30, 1918		
Tables 1 and 2	Lt.-Col. Elting	Major Bailey	Lt.-Col. Elting.
Tables 3 and 4	Major Drennan	Major Stewart	Major Drennan.
Tables 5 and 6	Capt. Noble	Lt.-Col. Lewis	Capt. Noble.
Tables 7 and 8	Capt. Zimmerman	Major Kocyan	Capt. Zimmerman.
Tables 9 and 10	Major Ransohoff	Major Long	Major Ransohoff.

This is a most satisfactory schedule, for teams can work day after day without tiring. When a team is off duty it should not be subject to call.

Each two tables should be a unit. Instruments should be provided for each two tables. These should be carried by the Evacuation Hospital and the teams should sign for these to the head nurse when they report to the hospital. This does not lead to a reduplication of instruments, an argument which might be raised against this arrangement, for each team would be sent out with a separate operating set if each team were provided with instruments. Instruments should be pooled, and this is possible when they belong to the Evacuation Hospital. When pooled there will be no necessity for a new set-up when the teams change a shift. Time will be saved in this way. Each two tables should be provided with an instrument sterilizer. One large sterilizer for basins and pans will be enough to care for the needs of the Hospital.

Fracture Teams. A fracture team of two men should be assigned to each hospital to splint the fractures. These men can save the time of the surgeon as they can begin splinting as soon as the operation is finished, permitting the surgeon to start on the next case. The splinting of fractures has become so important that special training is needed. When the splints are properly applied in the operating room there is usually but little need for readjustment when the patient is evacuated. The splints are better applied when a fracture team is employed. As patients stand transport so much better when splints are properly applied there can be no argument concerning the need or usefulness of such a team.

A shock team, if attached to the hospital, should be under the supervision of the most experienced surgeon. Harmony and coöperation should exist between the two. The experienced surgeon is the best judge of the condition of the patient and can best estimate the chances of surviving an operation. The shock team, in our opinion, should be subordinate to the most experienced surgeon, to whom these patients should be assigned.

An officer should be detailed at night to have general supervision of the wards. Five officers under him will be able to take care of the work to be done at this time. In case of an evacuation being required at night other officers may be required, but usually six officers can easily perform all the duties required.

NURSING. Fifty nurses, including the chief nurse and the sixteen nurses assigned to surgical teams, will be sufficient to care for the needs of a hospital such as the one being considered. Twenty-two of these should be assigned to ward duty during the day and eight during the night. Six nurses in addition to those with the surgical teams are required in the operating room. Three of these should be on a day shift of twelve hours and three on a night shift of the same length of time. One of these should be a supervisor of the operating room, one an assistant and the third should have charge of the supplies. But one nurse will be required to make supplies during an active period, for the supplies provided during a lull should be sufficient to carry the hospital through the next active period. One nurse can prepare the supplies actually required during an active period if such provision is made.

The remaining nurses are assigned to surgical teams. In some instances a nurse must serve as an anesthetist.

NUMBER AND DISTRIBUTION OF ENLISTED MEN. Because of the demands made upon an evacuation hospital during the latter months of the war it was found necessary to increase the number of enlisted men. This was necessary because of the need of taking down the hospital quickly and of setting it up rapidly when the site selected for it had been reached. Three hundred and twenty-five enlisted men should be attached to a 500-bed hospital.

The following are the details of enlisted men:

Company office: 1 top-sergeant, 1 typist (private), 1 orderly (private).

Quartermaster's Department: 1 sergeant, 1st cl.; 2 privates in office; 4 privates; 2 truck drivers; 2 motorcycle drivers.

Salvage tent: 1 corporal; 1 private.

Patients' valuables and effects: 1 sergeant; 1 private.

Medical supply: 1 sergeant; 1 private.

Kitchen: 1 sergeant, 1st cl.; 12 cooks; 2 kitchen police.

Laboratory: 1 sergeant; 2 privates.

Dental supply: 1 private.

Dispensary: 1 sergeant; 1 private.

X-ray: 2 corporals; 12 privates.

Operating room: 1 sergeant, 1st cl.; 2 sergeants; 22 privates; total number required day and night.

Overseer of ward orderlies: 1 sergeant.

Headquarters office: 1 hospital sergeant; 1 sergeant, 1st cl.; 1 sergeant; 1 interpreter (private); 1 private.

Registrar's office: 1 sergeant, 1st cl.; 1 corporal; 2 privates.

Number of officers and men in receiving ward: Day—1 officer; 2 sergeants; 1 corporal; 9 privates; night—1 officer; 1 sergeant; 1 corporal; 11 privates.

Sharp instruments should always be at hand, and one of the detachment should be detailed as an instrument sharpener. A large supply of knives should be kept on hand for débridement, which should preferably be performed with sharp knives. Some prefer scissors to a knife for this purpose. Scissors do, however, crush the tissues to some extent. Scissors are to be preferred to a dull knife.

Records. Two typists should be assigned to the operating room, and when the operation is completed it should be dictated. A fairly full, but short, concise history should be given. Many of the histories in evacuation hospitals were so short that they gave no clue as to what had been done. In many instances they were lost on the way back. The necessity of an accurate, well-written history is imperative. It is only occasionally in U. S. General Hospitals that one can find a record of the type of operation that has been performed. The field medical cards have been taken away *en route* to the hospital. We have under observation now nine cases of supposed primary nerve suture. We are certain of but one of these. In this instance the patient has a typewritten history of the findings at operation and the operation performed, but no field medical card.

The histories are of so much importance and are required so often that we believe that the field medical cards should not be given or attached to the men. They should be carefully guarded so that they will not be lost or mutilated. They should be given to the officer or private in the hospital train who should see that the cards are delivered to the hospital to which the sick and wounded of his train are assigned.

Technic to be Employed. Operations should, as a rule, be performed upon the litter. The patient is thus saved the discomfort of moving. After dry shaving the skin should be cleansed with gasoline; after the gasoline has evaporated iodin should be applied. This technic, which is simple, proved to be very satisfactory.

Wounds should not be sutured because of the rapid evacuation. Wounds of the skull or its contents—sucking wounds of the chest; wounds of the abdomen; wounds of the knee-joint and facial wounds may be sutured. In the remaining cases the wounds should be left open. If the patient could be watched, primary suture might be attempted.

The Evacuation Hospital as an Educational Center. In addition to its other functions an evacuation hospital should serve as an educational center. Because of the opportunity offered in the number of wounded received and the recent wounds which may be observed it should serve as a school for developing military surgeons. The officers should first be detailed as observers. They should then become assistants, and afterward, when they have become experienced, they should become heads of surgical teams.

Evacuation hospital work is usually regarded as rough, somewhat careless work. This is a misconception. The surgery done in evacuation hospitals should be done with the same care as traumatic surgery of civil life. Judgment must be developed, and judgment can only be developed when a large number of these types of cases are observed and carefully studied. For those who are to engage in professional work the evacuation hospital affords many more opportunities for the development

of military surgeons than schools established 3000 miles or more from the seat of surgical activity. A thorough review of anatomy should be given at such schools, but the actual work in military surgery should be given in the advanced zone. Men working in evacuation hospitals should be sent back to base hospitals from time to time so that they may see the result of their work. By noting failure they can change the character of the work when necessary and add to the general efficiency of the work. A close coöperation and interchange of ideas between the officers of the advanced zone and base will add greatly to the efficiency of the Service.

A hospital such as the one just described should be a mobile unit. One hospital of this kind can take care of the wounded of a division. In one instance that I know of such a hospital practically took care of the wounded of two divisions.

Ten teams working twenty-three hours a day should never perform less than 150 major operations, working at maximum efficiency; ten teams could perform 200 major operations. The average number of operations performed by ten teams during this length of time, will be about 170.

DISCUSSION ON THE PAPER OF DRS. LEWIS AND LEARY

Dr. J. M. T. Finney, Baltimore:

I have little to say, except that, of course, Dr. Lewis has been dealing with more or less ideal conditions—less usually. He has set a standard which it would be pretty difficult for others less competent to follow. Everybody who knows Dr. Lewis will know that I am not exaggerating when I say that his organization was a particularly efficient one. I am not exaggerating either when I say that his commanding officer was also highly efficient. In considering the question of evacuation hospitals, one has to deal with actual conditions; in the first place, with the personal equation of the staff from the commanding officer down; then with the terrain, the particular location that is assigned you; then with the transportation facilities, and then last, but not least, with the enemy. All these factors have to be taken into account, and the very efficient man, of course, will use every means at his command to obtain results. The man who is not quite so efficient, will not have quite such a satisfactory "show." One thing to be borne in mind is that in France we never had at any time from the beginning of the war until the armistice was signed more than 50 per cent.—hardly that—of the medical personnel that we should have had in order to care for the wounded properly. Bearing this in mind, it means that everybody was working at high tension; it means also that most of the surgeons were doing the work of two or three men—they had to do it. This was true also of the nurses and of the enlisted personnel. And so the conditions were never ideal. It was always a question of doing the best you could under the conditions that confronted you. The fact that the work was done so well—and it was well done—was due to the fact of the splendid spirit of self-denial, of coöperation, of team-work on the part of the entire medical department—doctors, nurses and enlisted men; and I want especially to emphasize the spirit of the last, because those men certainly did as good work as it was possible for any set of men to do.

Dr. Donald Macrae, Jr., Council Bluffs:

I feel very much disappointed that in all these meetings I have not heard a word about mobile hospitals. I happen to have had the privilege of not only commanding Mobile Hospital No. 1, but acted as chief of the surgical staff as well. In order to tell you in a few words what we did, I might say that at Couloumiers, at the beginning

of the Château Thierry drive, we were attached to an evacuation hospital. An evacuation hospital, of course, receives all classes of patients, and in this particular place there were so many disabled soldiers coming in that great difficulty was experienced in handling the cases which required the greatest amount of attention. The two outfits handled 26,000 cases in five weeks, beginning June 12, 1918, the mobile hospital taking only the wounded. The principal feat was to remove the patients from the ambulances and to sort them out, taking the worst cases for operation, causing much delay. Many of these cases were gassed, some sick, and the result was great confusion. Therefore, I do not exactly agree that an evacuation hospital should be for the care of the seriously wounded.

We should adhere to the old army field regulations. An evacuation hospital near the firing line is not an evacuation hospital as understood by the nomenclature of the army. I think a hospital with a small constituency, so far as operating facilities are concerned, should receive only the class of cases expected to be received by it. After we became separated from the evacuation hospital and worked entirely alone we found that we were being sent only operative cases, as a result of a divisional triage, which worked most satisfactorily. After the Château Thierry drive our organization was of the greatest benefit to the seriously wounded and the non-transportable cases, so that I do believe that the seriously wounded should be taken care of by special hospitals or units. The operating staff should do nothing but operate and take care of wounded men. Had the war lasted longer, or had we been in the game earlier, I am afraid that our statistics and our showing of primary suture would not compare well with those of our Allies, for the reason that the Americans would not stay long enough in one place to admit of long-time cases. As you know, with the British some of these evacuation and combination mobile hospitals (casualty clearing stations) were close to the line and remained there for many, many months. During my stay on the British front, Casualty Clearing Station No. 1 was only five miles behind the lines, and had been there for three years. Cases operated here could stand for primary suture and be taken care of. On the other hand, when the Americans came in there was no place for primary suture except in rare instances. When I got into the game with Hospital No. 1, in June, 1918, we had to contend with those who favored primary suture. Surgeons came down who expected to do this work, and we had to place ourselves against it because we found nearly all their primary suture cases sent back early became infected. Most of these operators had been trained either at a British casualty clearing or Evacuation Hospital No. 1, and

did not understand the necessity of room and quick evacuation necessary to a mobile hospital. So it seems to me that Mobile Hospital No. 1, which was really a French autochir, the result of four years' intensive work and investigation on the part of the French, the work of which Col. Crile can tell you, was a most wonderful organization. It was well equipped with *x*-ray camions, sterilization appliances, etc. There was a system of tents so arranged that one could go from one part of the hospital to the other without being exposed to the weather. I believe that the chief of the surgical service should not operate, but should be a man of large experience in surgery, with surgical sense, whose business it should be to pass from one table to the other and see what is going on, and see that orders are obeyed. This was the first step we took in assuming care of the large number of surgeons. We operated at Couloumiers twenty-eight operating tables day and night. The small hospital with which I was connected operated nearly 7000 severely wounded and non-transportables. I am thoroughly satisfied that we should have such a service with a large operating capacity, with a large number of surgeons capable of doing this work, and have other units with large bed capacity similar to this hospital. The old army regulations cannot be improved upon for caring for the wounded; however, the advent of gas gangrene and gas demanded additional units; these should be for surgery and gas, but in no sense evacuation hospitals. Evacuation hospitals could have a less experienced personnel with many beds and well out of the danger zone. I am not exactly in favor of having the personnel of teams permanently attached to one operating unit near the front; however, I will agree with Col. Lewis in this regard, if he agrees with me as to the status, situation, etc., of an evacuation hospital as described in U. S. F. R. At the front, however, the very best teams should operate, and it is obvious to anyone who has been there that it would be unwise to hold good teams inactive in a quiet sector while great battles are raging in others. I hope later to express my views more fully on this and kindred subjects. Dr. Lewis's organization as an evacuation hospital would be hard to improve upon, but if he expects to place this outfit near enough to the front to care for gas gangrene and gas, sick, etc., then I cannot agree with him, for then it ceases to be an evacuation hospital.

FOREIGN BODIES IN THE STOMACH

By RANDOLPH WINSLOW, M.D.
BALTIMORE, MARYLAND

The presence of foreign bodies in the stomach, while always of interest, is by no means uncommon. They are found in three classes of persons: First, in those who swallow objects accidentally; second, in insane or otherwise unbalanced individuals, including those who swallow articles with suicidal intent; and third, in mountebanks or professional jugglers, who eat glass and swallow other dangerous objects as a means of a livelihood. The articles that are swallowed accidentally are usually single and smooth, blunt or rounded in character, such as coins, marbles and pebbles, which, if not too large to pass through the esophagus, will usually also traverse the intestinal canal and be expelled per anum. But sharp-pointed and jagged objects are also swallowed accidentally, as pins, needles, hat pins, open safety pins, plates with artificial teeth and pieces of bone, which may become lodged in the esophagus, or if they descend into the stomach, may perforate this organ, or if they pass into the intestine may lacerate or penetrate the walls of this tube. A case of this character came under my observation many years ago. A man while eating a chop swallowed the articular process of a vertebra. He was taken with violent pains and soon died. I was able to get an autopsy and found the bone far down in the small intestine, the mucous membrane having been extensively lacerated by a sharp spicule projecting from the bone.

An almost similar case with, however, a more favorable result, was reported by Weishart in the *Münch. med. Wchnschr.*, April,

1906, vol. lxiii: A woman, while eating, swallowed a piece of calf's rib from which a sharp point projected. This caused violent pains and collapse, but eventually the bone passed per rectum and she recovered.

It is really remarkable that so many sharp and pointed articles do pass through the alimentary canal without producing serious results, such as pins, open safety pins, knife blades, tacks and nails. In this connection the following case is of interest:

Swallowed a Nail. B. J., boy, aged two and one-half years, on August 17, 1914, swallowed a wire nail. He was admitted to University Hospital in my service. An *x*-ray examination showed the nail lodged at the cardiac end of the stomach. He did not appear to be suffering in any manner from the nail, nor was there discomfort at any time during his stay in the hospital. On August 22 the nail passed per anum. No purgative was given at any time. Skiagraphs were taken daily, which showed the nail passing slowly through the intestinal canal. The descent of the nail as shown by the daily skiagraph was not only very interesting but determined absolutely that no surgical interference was indicated.

Multiple objects are swallowed either by the insane or by mountebanks. The number and variety of articles ingested is great. Practically all of these individuals come to operation sooner or later. Sometimes several years may elapse without any serious symptoms being experienced, but in many cases the reverse of this is true. I desire to place on record here the history of a case of multiple foreign bodies removed by gastrotomy from an insane woman in August, 1918.

Stomach Filled with Pins, Safety Pins and Other Objects. L. S. was admitted to University Hospital on August 15, 1918. The patient, a Russian Jewess, was admitted to the Springfield State Hospital for the Insane at Skyesville, Md., on November 8, 1916, with the diagnosis of dementia precox. She is married and is the mother of three children. At the time of her admission to this hospital she had been ill for four months. There was nothing of especial interest in her case from a surgical standpoint until

March 29, 1918, when it is recorded that she had nausea and vomiting with a little rise of temperature in the afternoon, but she did not appear to be in pain. She continued to eat well but a month later had to be fed through a tube. She has been losing weight.

FIG. 1.—Roentgenogram showing foreign bodies in stomach of patient (L. S.) before operation.

May 30. "She has been sticking pins in her ears and vagina, which have to be removed frequently. She has also been found with hair pins and safety pins in her mouth, which are removed

FIG. 2.—Objects removed from the stomach of patient (L. S.), August 17, 1918, by Dr. R. Winslow. Photographed after removal.

with difficulty. There has been some bleeding from the mouth, probably due to trauma from the foreign bodies."

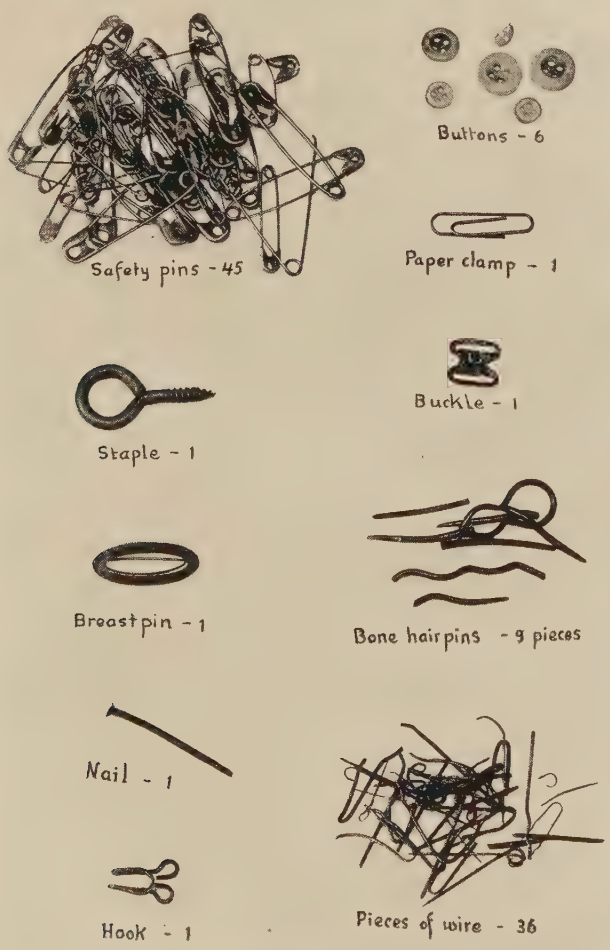


FIG. 3.—Objects removed from the stomach of patient (L. S.), August 17, 1918, by Dr. R. Winslow. Photographed after removal.

August 8. "She has vomited a brownish material that looks like partially digested blood. She has the same material in the stools. She is kept in bed and is showing marked signs of weakness."

August 12. It is recorded that "There is a hard mass in the stomach, which crackles under the fingers. Vomiting is of daily occurrence, the vomitus consisting of the same dark brown material, which is still found in the stools."

August 15. She was sent to the University Hospital for operation. She is thirty-four years old, and is a thin, undersized woman weighing less than 100 pounds. She cannot, or will not, speak English and we can get no statement from her in regard to her condition. On inspecting her abdomen an elevation is seen in the epigastric region, and on palpating this a crackling sensation is felt. She does not appear to suffer pain to any extent. An *x*-ray examination shows the stomach to be filled with an immense number of pins, hair pins, safety pins and other objects, with ten pins and a hair pin in the intestinal canal. Her temperature was practically normal.

Operation was done on August 17, 1918, under ether anesthesia. A right rectus incision was made, the stomach exposed and lifted partially out of the wound and surrounded with gauze compresses. The stomach was distended and a vertical incision was made into it, in order to avoid the vessels. At first I attempted to pick out the foreign bodies with forceps, but as they were so matted together it was necessary to enlarge the incision and insert the whole hand in the cavity of the stomach in order to dislodge and remove them. This was a difficult and somewhat dangerous process, as there was great liability of lacerating my hand on these sharp pointed objects as well as of puncturing the walls of the stomach. However, I succeeded in removing them entirely. The stomach walls were much thickened and the mucous membrane was inflamed, ulcerated and covered with an exudate. There was quite free bleeding from the mucous membrane. The incision in the mucous membrane was closed with two rows of catgut sutures and the outer walls of the stomach

with two rows of silk sutures. The abdominal wound was closed in tiers, without drainage. The patient stood operation well. When she was returned to her bed, Murphy's proctoclysis was instituted. Nothing was given by mouth for forty-eight hours, then coffee ℥j every two hours.

August 20. Milk ℥j and lime water ʒj every two hours.

August 21. Patient is in excellent condition; bowels moved several times. Proctocylsis discontinued and milk ℥ij and lime water ʒij every two hours allowed.

August 22. Milk ℥iij and lime water ʒiij every two hours.

August 23. Continue milk and give one soft boiled egg.

August 24. Milk with two soft boiled eggs allowed.

August 25. Milk ℥iv and lime water ℥ss every three hours and one soft boiled egg three times a day.

August 26. Milk continued and four soft boiled eggs allowed. On this date four straight pins, one straight hair pin and one bent hair pin were passed per enemam.

August 27. Milk ℥v, lime water ℥ss and five soft boiled eggs; slight suppuration in wound.

August 29. Six soft boiled eggs and milk as above. One straight pin passed per rectum.

September 1. Soft toast once a day is added to diet.

September 7. Soft diet. Patient has been sitting up for several days. *X*-ray shows a clump of three or four straight pins in lower bowel, but none in the stomach or in any other part of the intestinal tract.

September 10. Patient discharged to go back to the State Hospital. Subsequent to the operation her temperature was practically afebrile.

The following note was kindly furnished by the State Hospital as to the condition of the patient after her return to that institution:

October 14, 1918. "On September 10, the day she returned, her weight was 76 pounds; on October 12 it was 82 pounds. She is sleeping and eating well, is up and about the ward each day, and appears to be suffering in no respect from her unusual experience.

She is kept under close observation to prevent her from procuring her selected morsels. Mentally her condition is unchanged."

The foreign bodies removed from her stomach numbered 1290 different objects, as follows: Straight pins, 1059; safety pins, 45; hair pins, 129; pieces of bone hair pins, 9; pieces of wire, 36; buttons, 6; iron screw staple, 1; iron hook, 1; wire nail, 1; paper clamp, 1; garter buckle, 1; breast pin, 1. Besides these the skiagraph showed 10 pins and hair pins in the intestines, but at the time of her discharge all but three or four of these had passed naturally. The grand total of foreign bodies in her stomach and intestines on admission as shown by the *x*-ray and by removal was 1300, most of them sharp-pointed objects that were liable to perforate the walls of the viscera; that they did not do so is surprising. As to the length of time she had been indulging in this practice I am ignorant, but it must have taken a long time for her to secure so many articles, especially as she had been detained in a hospital for the insane, where she would have been under constant observation, a year and a half.

The interest in this case centers not so much in an operation of gastrotomy for the removal of foreign bodies as in the number and the dangerous character of the objects removed. As far as I am aware, this is the largest number of individual objects that has ever been removed from the stomach of the living human being, though Vandivert and Mills report the removal at autopsy of 1446 objects from the stomach of an insane mulatto woman? *Jour. Am. Med. Assn.*, January 21, 1911, p. 180. There are, however, many remarkable cases of multiple foreign bodies removed by gastrotomy reported in the literature. I shall not attempt to make a statistical report of such cases, but will mention a few of the most remarkable examples.

Meisinbach, St. Louis (*Jour. Am. Med. Assn.*, 1898, xxx, 513), removed from the stomach of a mountebank 25 staples, 15 screws, 6 horseshoe nails, 30 wire nails, 19 cartridges and 2 broken knife blades which had been in the stomach nine years.

Von Quast, Kansas City, Mo., removed from the stomach of a woman 9 ounces of broken glass, 2 pocket knives, 1 barbed-wire

staple, 5 knife blades, 3 screws, 1 horseshoe nail, 16 tacks and 9 nails. See article by Friedenwald and Rosenthal, *New York Med. Jour.*, July 18, 1903.

Halsted, Baltimore, from the stomach of a mountebank, 74 grams crushed glass and 208 other objects, including 21 pieces dog chain, 4 watch chains, 1 brass chain, 2 pieces of chain, 10 horseshoe nails, 54 wire nails, 35 ordinary nails, 8 screws, 2 screw-eyes, 7 knife blades, 1 knife handle, 50 tacks, 12 pins and one piece of tin.—*Johns Hopkins Hosp. Rep.*, 1900, p. 1047.

Inch, Kalamazoo, Mich., 2 hat pins, 3 hair pins, 2 pieces wire, 1 button-hook minus handle, 1 screw head and 1 brass tack, and the patient subsequently passed handle of button-hook in 2 pieces, 2 carpet tacks, 3 pins, 1 screw, 4 nails and 1 piece wire.—*Jour. Am. Med. Assn.*, 1902, p. 603.

Warbasse, New York (*Annals of Surgery*, xl, 909), operated twice on a juggler, who was suffering from gastric tetany due to foreign bodies in the stomach, and on each occasion removed a large number of objects, such as nails, chains, etc.

Gaylord, Erie County Hospital, removed carpet tacks 453, penknife blades 41, screws 142, pen points 40, wire chain 3 inches long 1, and 6½ ounces ground glass, the whole weighing 2 pounds 3 ounces (l. c. Friedenwald and Rosenthal).

Heinz Marks, St. Louis, removed glass, tacks, nails, screws, etc., weighing 16 ounces (l. c. Friedenwald), *Med. Fortnightly*, St. Louis, May 15, 1892.

Balfour, Rochester, Minn., *Jour. Am. Med. Assn.*, lxvi, 421, 1916, removed 7 teaspoons from the stomach of an insane woman.

Autten, St. Louis, 2 gastroliths, weighing 517 grams (l. c. Friedenwald), *Med. Fortnightly*, August 14, 1894.

Kortmann, 2 shellac stones, weighing 670 grams. This man worked in a porcelain factory and drank an alcoholic solution of shellac, which solidified in his stomach. They had been in the stomach seventeen years (l. c. Friedenwald), *Deutsch. med. Wchnschr.*, 1897, E, No. 26.

Hairballs in the stomach form a large subject and are thoroughly considered by Rudolph Matas in an excellent article

published in the *Tr. Southern Surg. and Gynec. Assn.*, 1915, p. 572.

While many single objects pass through the intestinal canal and are safely extruded, multiple foreign bodies usually lodge in the stomach and require to be removed by gastrotomy. At the present time an exact diagnosis is possible by means of the skiagraph and this method of examination will not be neglected by a careful surgeon. The removal of foreign bodies that have lodged in the stomach is a comparatively safe procedure and the percentage of recoveries is very high, even when they have remained in the viscus a long time. Naturally, the sooner they are removed the better the result is likely to be.

DISCUSSION

Dr. S. J. Mixter, Boston:

In connection with Dr. Winslow's paper it might be said that any one interested in dogs knows that they often die from "skewer" abscesses, caused by swallowing wooden skewers in scraps of meat, or are cured either by the spontaneous opening of the abscess or by surgical opening of the abscess, out of which the foreign body comes. That happens also in human beings. I have had two dogs die from swallowing wire nails. I saw a man in the operating room who had a lump just above the umbilicus. I said it looked rather like a skewer abscess. Upon opening it up there was extruded a lot of yellow pus, which, interestingly enough, proved to be actinomycosis, the first recognized case I think in Boston of human actinomycosis. In this abscess were two large fish bones. Evidently the actinomycosis had followed along the track of the bones.

Dr. Willy Meyer, New York:

Years ago I had to operate upon what seemed to be a gastrocolonic anastomosis in a hysterical girl, when I found a large knitting needle sticking out of the stomach, partially within the stomach and partially without. The needle was extracted and two sutures introduced, and the patient recovered. This was before the days of the *x*-ray.

Last year a baby, of a few months, came under my care who had swallowed an open safety-pin. Fortunately the family physician had ordered arrowroot. The *x*-ray showed the safety-pin in the stomach. I, of course, did not operate at once, as requested by the parents, but continued feeding with thick material; the pin passed within twenty hours. I saw a similar case in the country, when a boy of four years had also swallowed an open safety-pin. In this case we used the well-known potato cure and the boy passed the pin two days later. A most interesting case was published in the *Journal of the American Medical Association*, in which a safety-pin was found to ride on the pylorus, half in the stomach and half in the duodenum; it could not be passed. A gastrotomy was done and the pin removed, with recovery of the patient.

Dr. William J. Mayo, Rochester:

I might add to the extremely interesting cases of Dr. Winslow two cases in which hat-pins were swallowed, one of them before the days of the *x*-ray. The patient was supposed to have swallowed a hat-pin, though it was not definitely known. A little abscess near the

umbilicus was opened and the point of the pin presented at the hole; the pin was drawn out and cut off next to the head in such a way that the head dropped inside and passed out of the intestinal tract. I have seen other similar cases. I do not know whether the old-fashioned potato treatment has any scientific support, but it is a fact that patients who have swallowed open safety-pins, etc., will sometimes pass out the foreign body if given a big, mushy mass of potatoes, when it would seem impossible to pass it out spontaneously.

Dr. John J. Buchanan, Pittsburgh:

A few years ago I had occasion to see a child of two years who had swallowed a sewing-machine needle. I watched it with the *x*-ray for two days and judged, finding it stationary, that from the length of the needle it could not pass around the curve of the duodenum in a child of that age. This was contrary to the opinion usually held, that anything that will pass through the pylorus will pass all the way. This had passed through the pylorus and I thought it would be easy enough to get it. I therefore made a laparotomy and found that I could not reach it from in front. So I had to free the duodenum according to Kocher's method and lift it to one side to get at the needle posteriorly. I am glad to say the child made a good recovery. This is the only foreign body I have ever seen that, after passing the pylorus, did not keep on its way with the mess of mashed potatoes, to which Dr. Mayo has referred.

Dr. John H. Gibbon, Philadelphia:

In regard to finding foreign bodies in the stomach, I did an abdominal operation some three years ago on a three-year-old child who had had a twenty-five cent piece in the stomach for two weeks. I could feel nothing in the stomach after opening the abdomen, and I fortunately concluded not to open it; but putting my finger in the rectum removed the coin. The last *x*-ray plate had been made forty-eight hours before operation. I shall see hereafter that a plate is made immediately before operation in these cases.

OPERATIVE TREATMENT OF PEPTIC ULCER; REMOVAL OF ULCER WITH GASTRO-ENTEROSTOMY, OR GASTRO-ENTEROSTOMY ALONE

By JOHN B. DEAVER, M.D.
PHILADELPHIA

There are no hard and fast rules in abdominal surgery. Each case that presents itself must be treated along the lines that give promise of the best results. Therefore the answer to the subject I have chosen to discuss would be: it depends. But in order to be a little more definite I had better say, that other things being equal excision of the ulcer, or resection followed by gastro-enterostomy, is the procedure of choice. However, there is a large *but* that looms up to modify this statement. Other things rarely are equal, and the powers, whichever they may be, that afflict humankind with peptic ulcers do not always place them where they can without great difficulty be removed; or, as sometimes happens in perforating ulcers, the surgeon is spared the trouble of removing them.

That others regard the excision of the ulcer as the most desirable thing is evidenced by the work of Balfour at the Mayo Clinic, where with the ingenuity that characterizes the methods of that institution the cautery has been requisitioned for the treatment of peptic ulcers and has proved of particular value in treating those that are not easily accessible to the knife. The procedure, as described by Balfour, depends not only on heat, but mainly on complete perforation with the cautery as an essential to the success of the method, inasmuch as clinical experience has shown

that spontaneous perforation of gastric ulcer, if complete, usually cures the ulcer and also the patient. Combined with gastro-enterostomy the method has given excellent immediate and remote results, particularly with regard to gastric motility.

I cannot entirely agree with Balfour's implication that spontaneous perforation if complete cures the patient. It has been my experience to observe recurrence of perforation in two instances. In one of these the patient, after being operated for duodenal perforated ulcer, returned later with a second duodenal perforation, and again some time afterward with a perforated gastric ulcer.

It is claimed by many that gastro-enterostomy of itself is a curative measure, and so it is for a time. But the ulcer, if it is allowed to remain, may or may not heal, and experience with the "may not" has shown that in order to insure a positive result the ulcer must be removed.

What does gastro-enterostomy without resection of the ulcer do? It makes an indirect attack on the ulcer, diminishes the acidity of the gastric secretion by neutralization with the alkaline juices of the intestines and the pancreas; thus reducing the various distressing symptoms, especially pylorospasm, that accompany peptic ulcer. If the stoma is large enough and properly placed it also obviates the stagnation of the gastric contents and hastens the evacuation time of the stomach, which often occurs in less than normal time; the irritating action of the food and the digestive secretions is then removed and the ulcer given a chance to heal. You will notice that there are two *ifs* which vitally affect the usefulness of the operation. I believe it is generally conceded that the food will seek its natural outlet wherever there is provision for it to do so, and that in the presence of any degree of patency of the pylorus after gastro-enterostomy some of the food passes through it. Cannon and Blake, on the basis of their fluoroscopic experimental studies, have maintained that the new opening probably closes in the course of time if the pylorus be patent; they also observe that the food as well as fluids circulate through the pylorus and duodenum and

back through the anastomosis to the stomach without causing a vicious circle. It has been my experience that a gastro-enterostomy properly made and properly placed, with a patulous pylorus does not close. I have repeatedly observed this in many secondary operations which I have made, as well as by the barium or bismuth meal in a fluoroscopic examination. With the stomach empty the pylorus is the lowest part of the organ, and at this point intragastric pressure is three to four times more than at the cardia, so that the artificial opening must be made as large and as near the pylorus as possible. Hartmann, who has probably made the most comprehensive study of the question of the functioning of the gastro-enterostomy opening, shows experimentally that the physiological process with a permeable pylorus depends on the position of the stoma. If it is near the pylorus the greater part, but not all of the chyme, passes through the new opening, a little passing through the pylorus, and when the opening is made at a distance from the pylorus near the cardiac end of the stomach almost all the chyme passes through the pylorus.

We have therefore these two important items to consider when doing gastro-enterostomy without excision of the ulcer.

What does resection plus gastro-enterostomy do? I cannot think that anyone, unless he is dealing with a very small ulcer at a most favorable location, would simply remove an ulcer and fail to follow it up at once with the anastomosing operation unless he wants to have two operations to do instead of one. The radical operation presents the same advantages as the less complete one with the added benefit of a direct attack on the ulcer, and thus at one stroke reduces, if not removes, the chance of carcinomatous degeneration (in gastric ulcer), of perforation and hemorrhage, except in case of overlooked multiple ulcers, which are rare.

Perforation of peptic ulcer is by no means so rare as to be a negligible quantity to be reckoned with in the treatment of chronic ulcers. In the past year, January 1, 1918, to January 1, 1919, it occurred in about 5.2 per cent. of my cases. Every

medical man of large experience, I am sure, has had the unpleasant opportunity of observing perforation occur while a patient has been in the medical ward of a hospital or in his own home undergoing medical treatment for what is essentially a surgical condition. The proper time for medical treatment for the results of chronic indurated peptic ulcer is not before but after the operation (if treatment is then still needed). For with the removal of the ulcer or with its exclusion from the corroding action of the digestive juice the damaged mucosa has a better chance of responding to treatment and a better chance of complete cure.

Carcinomatous degeneration of gastric ulcer, in spite of widely divergent statistics on the matter, is a decided menace and one that cannot be ignored.

The excision of a chronic ulcer or the radical removal of the ulcerous site may be attended with a somewhat greater mortality in the hands of some, for probably nowhere does the personal equation of the operator enter more than in the operative treatment of peptic ulcers. The radical operation doubtless presents greater difficulties, which experience can in a measure overcome but which early operation can materially reduce. It is the difficulty of transgastric resection, for example, for a chronic ulcer at the lesser curvature that leads many a surgeon to content himself with a gastro-enterostomy, especially when the condition is of long standing and has led to hour-glass contraction of the stomach, and extensive adhesions involving the pancreas, the gall-bladder and the intestine. But he cannot expect the same satisfactory end-results as from resection. It is indeed remarkable how well resection of large portions of the stomach is borne even by undernourished and emaciated individuals, and how gratifying are the end-results of the operation.

There are, of course, circumstances when it is expedient to omit the gastro-intestinal anastomosis. As, for example, in ulcers distal to the pylorus with very little exudative induration. Simple excision of such an ulcer may suffice. This also applies to saddle-back ulcers and those situated on the lesser curvature toward the cardia, for which circular resection is the indicated

operation. It has been my practice for a number of years not to follow circular resection with a gastro-enterostomy. But I have on two occasions been obliged to do a posterior gastro-enterostomy as a secondary operation after circular resection; since which time I am becoming convinced of the advantage of making the anastomosis at the primary operation.

For perforation of a duodenal ulcer I find it best after closing the perforation to plicate the duodenum and fortify the area by covering it over with the gastro-colic and the gastro-hepatic omentum, completing the operation with a posterior gastro-enterostomy. This I believe is being more and more recognized as the proper procedure for acute perforating peptic ulcer. The two-stage operation has lost any favor that in the early days of gastric surgery it may have enjoyed.

In addition, I have also made it a practice, in recent years, to remove the appendix, and if necessary the gall-bladder at the same operation. Since 1915, up to January, 1919, I have treated 18 perforating peptic ulcers, and in fourteen of these appendectomy, and in two, in addition to the appendectomy, cholecystectomy formed part of the operation.

It may not be out of place to record the total number of perforations I have thus far treated. Up to January 1, 1919, these have numbered 56 operations with two deaths. One death occurred twenty-two years ago and the other during the past year; thus making fifty-four consecutive operations with 100 per cent. recoveries. In all but two of the entire series closure of the perforation followed by gastro-enterostomy was the method employed.

LIFE EXPECTANCY OF PATIENTS FOLLOWING OPERATIONS FOR GASTRIC AND DUODENAL ULCERS

By DONALD C. BALFOUR, M.D.
ROCHESTER, MINN.

Efficiency in the surgical treatment of many diseases has been measured in the past by operative mortality, and by the permanency of relief which the patient has secured by operation. With the gradual development of surgical technic, and our increasing knowledge of surgical indications, operative mortality and relief of symptoms have been so favorably influenced that they have now in many fields apparently reached their limit of development. It is also true, however, that in all diseases life expectancy can be said to be the major consideration with the patient, and yet this consideration of preëminent interest to the patient has not received the study which it deserves, particularly in those diseases in which operation is conducted primarily for the relief of symptoms.

Diseases of the gastro-intestinal tract stand out most prominently as illustrations of this fact. With the advent of operations such as gastro-enterostomy, in which the normal functioning of the gastro-intestinal tract is changed, the question whether such procedures have influenced the length of life of the given individual becomes one of great importance in connection with the surgical treatment of benign lesions of the stomach and duodenum.

During the several years past we have been repeatedly asked by insurance companies whether a given patient, whom we have

operated on for gastric or duodenal ulcer, should be accepted as a good insurance risk. We have had impressions as to the advisability of accepting such risks, but until recently we have never had any actual proof of life expectancy after operations have been carried out on such persons as compared with a group of persons in the general population of similar age and sex.

As we have always realized the importance of securing positive information along these lines we accepted with readiness the proposal of the Actuarial Society of America that they should study the records at the Mayo Clinic and by their own methods carry out some follow-up investigations with regard to the length of life which may be anticipated in patients operated on for gastric and duodenal ulcer. This association has recently compiled and published the statistics, and although, in the main, they agree with information which we have been able to secure for ourselves, yet their methods of investigation, their system of accurate tabulation, and above all, their unbiased intrepretation of such information, add unusual interest and value to the figures which I present.

Unfortunately, there is no basis on which the results of the present investigation of operated gastric and duodenal ulcers can be compared with the results in non-operated cases. Not only are no statistics available as to life expectancy in non-operated cases of gastric and duodenal ulcer, but accurate statistics in this group will probably never be entirely possible, because the uncertainties in diagnosis discount more or less the dependability of such figures. On the other hand, surgical statistics are based on proved lesions, and on lesions in which medical treatment has failed. If proved statistics of non-operative cases become available, the surgeon will welcome the opportunity of establishing the fact that surgical measures of treatment are the most efficient from every standpoint.

The investigation carried out by the Actuarial Society of America was under the direction of Mr. Arthur Hunter, Chief Actuary of the New York Life Insurance Company. It is

first interesting to note the success of the methods employed by this society for tracing cases. Of a series of 2431 patients operated on for gastric and duodenal ulcer in the Clinic between 1906 and 1915, all but 108 were traced, a percentage record which I am sure has never before been approached.

The figures first show that the operative mortality from all causes[1] in 545 cases of gastric ulcers in which operation was done during this period was 4.5 per cent., while in 1684 cases of duodenal ulcer the operative mortality from all causes was 2 per cent. Gastric ulcer carries, therefore, twice the operative risk of duodenal ulcer.

The Association's investigations of the mortality in the years after operation show the following facts:

Gastric Ulcer. Five hundred and twenty-one patients were under observation on the average of 3.6 years, and in that time 88 (17 per cent.) died from all causes.

Duodenal Ulcer. One thousand six hundred and fifty-one patients were under observation on the average of 3.4 years, and in that time 85 (approximately 5 per cent.) died from all causes.

Gastric and Duodenal Ulcer. Ninety-one patients were under observation on the average of 3.8 years, and in that time 9 (10 per cent.) died.

Mr. Hunter's first observation on these statistics are most interesting. I quote *verbatim:* "The fact that 17 per cent. of those operated on for gastric ulcer have died within an average period of observation of 3.6 years, and the fact that 5 per cent. of those operated on for duodenal ulcer have died within an average period of observation of 3.4 years, are in themselves significant. While we cannot tell how many lives have been saved by reason of operation for duodenal ulcer, it may safely be stated that the survival for three and a half years after the operation of 95 per cent. is a high tribute to surgery. With such a serious condition as gastric ulcer, a death-rate in three and a half years of 17 per cent. of those operated on appears to

[1] The cause of death has not been considered in this study.

be low. While I cannot prove my statement, I believe that a much larger proportion of persons would have died but for the operation, and that many years of life in the aggregate were saved through surgical treatment."

The chief point of importance in these statistics, however, is gained by comparing the mortality figures of a group of patients subjected to operation for gastric and duodenal ulcer with a group of the general population corresponding in age and sex:

TABLE I.—GASTRIC ULCER

Deaths in group of 521 persons operated on:

Following the operation.	Deaths.
First year	36
Second year	21
Third year	11
Fourth year	7
Fifth year	7
Sixth year and subsequent	6
	88

General population group of 521 persons with like distribution as to age and sex observed during the same period of time:

Observation.	Deaths.
First year	8.2
Second year	6.5
Third year	4.9
Fourth year	4.1
Fifth year	3.0
Sixth year and subsequent	5.6
	32.3

It will be noted in Table I that the number of deaths in the first year following operation was about four and one-third times the deaths in a like group in the general population; in the second year this number was three and one-fourth times that of the general population, and in the later years it was still less. With an average period of observation, therefore, of only three

and one-third years, the deaths in the year following operation, when the mortality is highest, have much greater weight in the total than if the observations were conducted for a longer period.

In duodenal ulcer a similar comparison shows most instructive findings:

TABLE II.—DUODENAL ULCERS

Deaths in group of 1651 persons operated on:

Following the operation.	Deaths.
First year	22
Second year	20
Third year	9
Fourth year	10
Fifth year	11
Sixth year and subsequent	13
	85

General population group of 1651 persons with like distribution as to age and sex, observed during the same period of time:

Observation.	Deaths.
First year	24.0
Second year	18.6
Third year	14.3
Fourth year	11.2
Fifth year	8.3
Sixth year and subsequent	16.7
	93.1

Here we have the rather astounding fact that in the first two years following operation for duodenal ulcer the mortality is only that of the general population group, and that after the second year the mortality is actually less than in the general population group. These statistics illustrate very strikingly the fact which always has been recognized by surgeons: namely, that gastric ulcer is a much more serious condition than duodenal ulcer, not only from an operative standpoint, but from a standpoint of after-results, and that the patient with a gastric ulcer shows, as a rule, much more evidence of impaired general health than the patient with duodenal ulcer.

SUMMARY. 1. The percentage of operative deaths in the hospital following operation for gastric ulcer was fully twice that following duodenal ulcer, but the percentage in both cases was very low considering the seriousness of the condition.

2. The mortality during the three years following the operation among persons operated on for gastric ulcer was three times as high as that among persons operated on for duodenal ulcer.

3. The mortality among persons operated on for gastric ulcer decreases relatively after operation, but the data are not sufficient to determine the number of years which must elapse before the death rate is similar to that of the general population.

4. The mortality among those operated on for duodenal ulcer in this series was less than that among the general population.

5. The average age at time of operation of those operated on for gastric ulcer was forty-seven for men and forty-three for women; the average age of those operated on for duodenal ulcer was forty-four and forty-two respectively.

CANCER OF THE STOMACH AND ITS SURGICAL TREATMENT

By CHARLES H. MAYO, M.D.
OF ROCHESTER, MINNESOTA

Probably no word in medicine is more depressing to the patient than that of cancer in the diagnosis of his disease. We are assured by most clinicians that cancer is on the increase; possibly this increase is more apparent than real and is due to the greater general diagnostic ability of the medical profession and the better facilities for obtaining statistics. A general knowledge, as well as fear, of the disease is gradually spreading, largely the result of the propaganda of the publicity committee of the American Medical Association, and the work of the special cancer commissions, all of which is creating a favorable evolution of opinion, and causing more persons to seek treatment during the earlier stages of the disease.

The most common cancer is that of the stomach. More than one-third of the cancers in men and more than one-fifth of the cancers in women appear in this organ, and inasmuch as the condition in nearly one-half of such patients who come to the physician for examination is inoperable, there is room for some improvement in the matter of securing earlier recognition of the disease. At best, however, the gain will be comparatively small over present conditions, because in many instances the disease gives but few symptoms until it is far advanced, and because approximately 75 per cent. of cancers of the stomach are so located or of such a type that early metastasis takes place into glands and into other organs, or it may become grafted throughout the peritoneum; to prevent this early operation is essential. About one-fourth of gastric cancers are

confined to the stomach, and in this group if glands are involved they are in or connected with its wall without papillary outgrowth. These are the most favorable cases for operation, and yet all of this type are not operable for various reasons, advanced age, general debility, complicating diseases, or extensive involvement of the stomach. In the inoperable group may be placed the cases involving the cardia, approximating 10 per cent. of the gastric cancers.

The literature concerning the general subject of cancer, especially of its etiology, is voluminous. Usually such articles are written with the object of proving special theories; for example, that cancer is or is not an hereditary disease, that it is caused by some unknown infection, or that this infection is water-borne, that it is due to malnutrition, general and local, and hence is a medical disease; that it is due to acids, especially of the sulphurous type, or to the excess of cholesterol. Cohnheim's theory of tissue displacement as a cause has long since been refuted. In taking a general survey of the various theories and reviewing the clinical evidence, it would seem that not one, but several conditions are essential to the development of cancer. The influence of heredity probably does not extend beyond an inherited cell weakness in which extra demand on the cell for division may early exhaust its controlling agent. The great influence of local irritation, which in some instances is undoubtedly chronic infection, is a fact quite generally accepted. No one theory, however, can account for the change in the cell that causes it to adopt lawless existence and to lose its harmony with community life. There is little change from the normal in the cancer cell, yet by the microscopic study of a group of cells and their relationship to surrounding tissues, cancer can be identified positively. An acid condition in the surrounding fluid also seems essential to cancer activity. Hot drinks are probably a cause of no little importance in producing cancer of the stomach.[1] Chronic ulcer is the most important

[1] Mayo, W. J.: Cancer of the Stomach, Surg., Gynec. and Obst., 1918, xxvi, 367–370.

factor to be considered in these cases, as in well over 40 per cent. there is a history of ulcer varying from many months to several years before the onset of cancer. When seen early such cancers are found to have developed on the margin of an ulcer. In such location the demand of cell renewal is constant; when some cell exhausts its controlling granules in the division, and reverting to single cell type, becomes parasitic, we may have the beginning of cancer, but only if other factors are present. The type and growth is dependent on the basal cell and the environment. In a general way it may be said that the nucleus is proportionately larger in the cancer cells and is ready for division with less than the average amount of cytoplasm surrounding it. Individual cells, as well as groups, must be studied. The various parts of the cell, taking different colors through the varying action of stains, show the complex chemical structure of the protoplasm. It is within reason to assume concerning the normal division of a cell that its control is the centrosome; possibly other granules may serve this purpose. Cell growth in cancer is undoubtedly stimulated by acidity or greatly lowered alkalinity. In this connection it is of interest to mention the work of Loeb. He found by a brief immersion of the unfertilized eggs of sea urchins in a 1 per cent. solution of butyric acid and sea water, that the eggs became fertilized and took on active growth, without sperm. On the other hand, it has been shown that eggs of certain types of lower animals that develop in water, when placed in 0.6 per cent. saline solution develop with frequent anomalies, especially of the higher nervous system, the last addition in evolutionary life.

The greatest number of cancers come in the area of highest acidity, the stomach. Ninety-eight per cent. of intestinal cancers are in the colon, while cancer in the small intestine is relatively rare—about 2 per cent. Cancer in the urinary bladder is not uncommon, while in those organs with a limited period of activity, such as the breast, uterus and prostate, a normal degeneration often becomes a pathological one, the stimulating influence probably being of a chemical nature. Cancer of the

duodenum is exceedingly rare, yet ulcer of the first portion of the duodenum is nearly four times as frequent as ulcer of the stomach, and while there is opportunity for involvement by continuity of tissue from the most frequent site of cancer in the body, the stomach, this does not occur. Ulcers appear in the first portion of the duodenum as it is bathed by the acids of the stomach before they are neutralized by the secretion of Brunner's glands; ulcers do not appear in the alkaline portion of the intestine below the common duct, although they may be found in a gastrojejunal opening which has there been rendered acid.

While I am not presenting this subject from the standpoint of diagnosis, I wish to refer to the progress which has been made in the diagnosis of gastric cancer, and to corroborate Carman's observations on the operability of cancer of the stomach as determined by the *x*-ray. Without the *x*-ray we would be back to the old methods of determining diagnosis, namely, by cachexia, loss of weight, achlorhydria, obstruction, tumors, etc., which are all signs of advanced gastric cancer. At a time when the cancer syndrome is not positive but probable, the *x*-ray may be relied on to demonstrate lesions of the stomach in more than 95 per cent. of the cases.

In general the treatment of cancer by radium is proving successful in certain types of the disease which can be reached by the ray; in some instances cure is produced and in others growth is delayed. By care and filtering processes the various rays are controlled. The effect on the cell is chemical, influencing the protoplasm or the local fluids. Radium is most effective in growths with active circulation, as it has a marked influence on the wall of the bloodvessel. It also apparently acts on the cell nucleus, checking division, but it may be used to excess and cause local destruction. The *x*-ray acts on the cell protoplasm, checking growth, and it may also cause local destruction. Between these two conditions, the *x*-ray causes rapid epithelial proliferation, areas of which might at times be called precancerous. The cell having lost its controlling granules through the

ray's action and retaining its nucleus and cytoplasm will become malignant when surrounded by the proper biochemic fluids. This shows that under certain conditions cancer cannot only be produced but controlled. As yet radium and *x*-ray are only palliative or a means of delaying the progress of gastric cancer.

From October 1, 1897, to January 1, 1919, we performed 2094 operations for cancer of the stomach. Seven hundred and thirty-six of these were resections with a mortality of 13.7 per cent., 746 were explorations with a mortality of 2.9 per cent., and 612 were palliative operations with a mortality of 11.1 per cent. The common type of operation was the Mikulicz, Hartmann, Billroth No. 2, of which there were 359, with a mortality of 12.5 per cent. There were 19 of the Billroth No. 1 type with a 5 per cent. mortality, 28 sleeve resections and 7 Kocher operations with a mortality of 14.2 per cent. each, 115 posterior Polya operations with a mortality of 14.7 per cent., and 120 anterior Polyas with a mortality of 13.3 per cent. The local resections, 12 in number, gave the highest mortality, 25 per cent. These 660 resections have been done since 1906. Prior to this the type of resection was not described in the records definitely enough to be included in a statistical report. The Billroth No. 1 operation consists of a resection of the pyloric end of the stomach, and the suturing of the duodenum to the partially closed distal end of the remaining portion of the stomach. Since the Y-shaped line of suture of this type of operation frequently leaked with fatal results, Billroth, with Mikulicz and Hartmann, developed the so-called Billroth No. 2 operation, which consisted of completely closing the end of the stomach and making a posterior gastrojejunostomy. The Kocher operation avoids the leakage of the Billroth No. 1 operation by attaching the end of the duodenum through an opening in the posterior wall of the stomach after the open end is closed, but tension here occasionally gave obstructive trouble or leakage (Figs. 1 and 2). Polya avoided the double operation of closure of the end of the stomach followed by gastro-enterostomy, by uniting, retrocolic, the whole open end of the stomach to an equal sized opening

made in the jejunum. In the Polya operation the newly formed end of the stomach consists of the jejunum, which spreads out as the stomach is filled; the opening may be from three to five inches in length, according to the size of the resected end of the

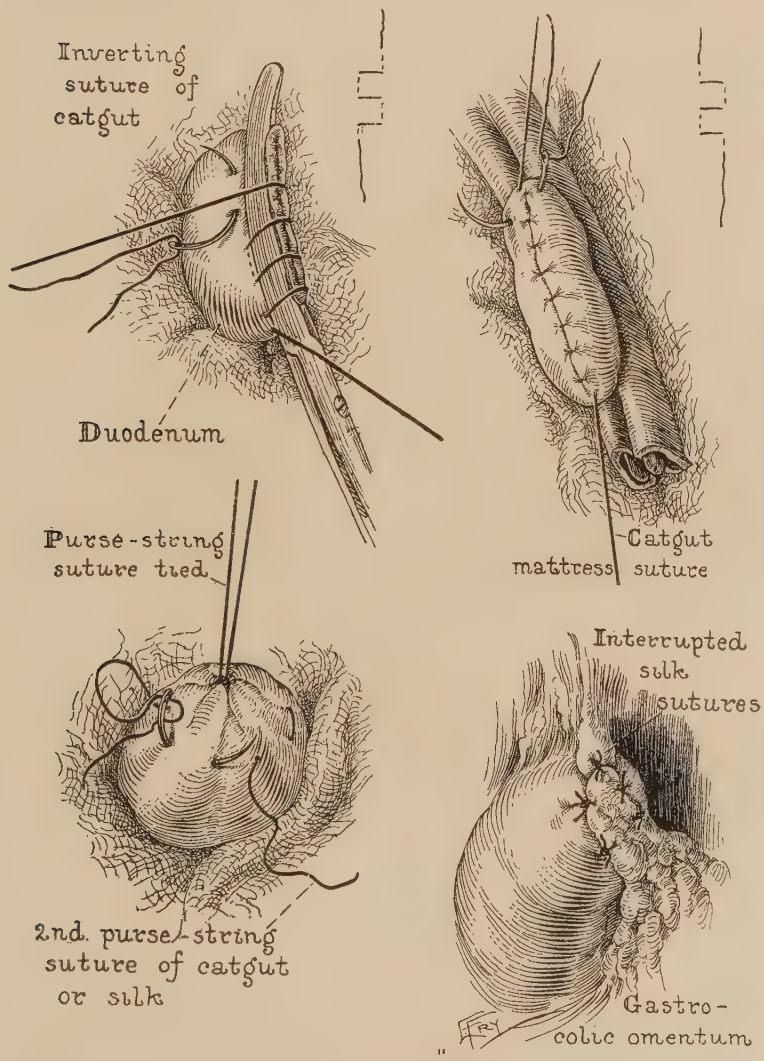


FIG. 1.—Two methods of closing and protecting the cut end of the duodenum.

stomach. If the opening is but three inches, the whole end of the stomach may be attached to the jejunum by incising the bowel a nearly equal distance; with each passing of the needle, the suturing loops catch a somewhat greater amount of the wall of the stomach than of the bowel. Since the bowel becomes

FIG. 2.—Jejunal attachment; approximate size of opening in bowel.

the stretched-out end of the stomach with an opening at each side of the attachment, proximal and distal, the delivery of gastric contents is not so well accomplished as it is with the partially closed end of the stomach with an ordinary sized gastro-enterostomy opening properly placed (Fig. 3). The

mortality-rate incident to the various operative methods is nearly the same; there is, however, some difference in the com-

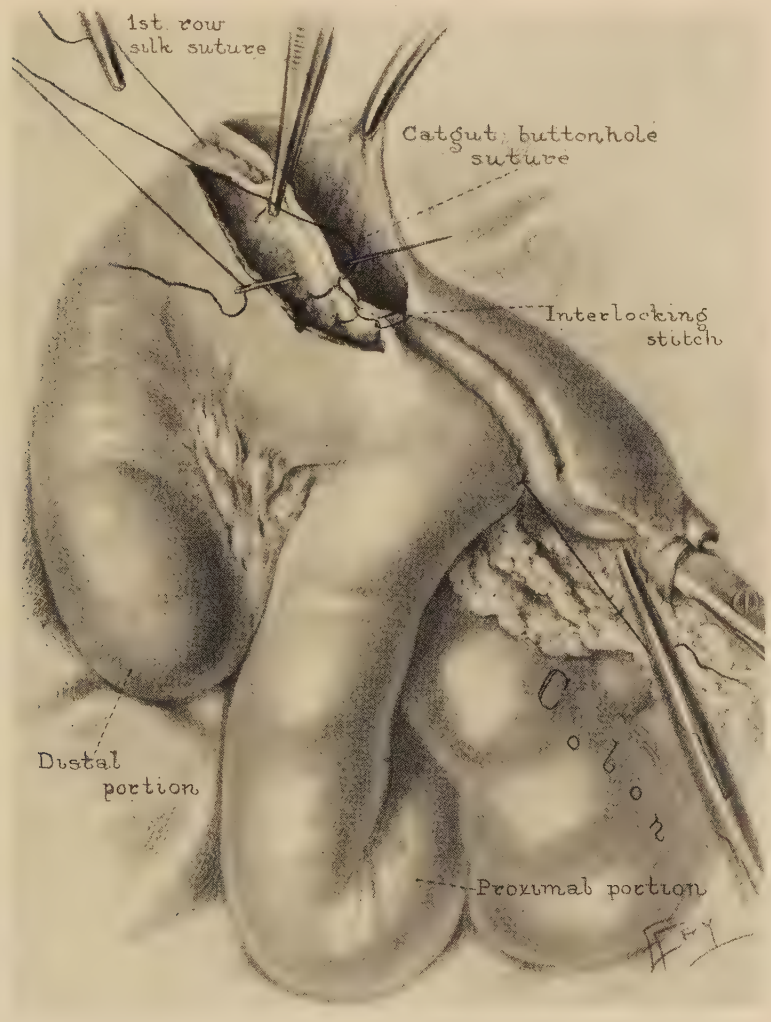


FIG. 3.—Gastro-enterostomy opening with partially closed end of the stomach.

fort and postoperative condition of the patient. In the operation described herewith this large opening is avoided by attach-

ing the jejunum to the posterior wall of the stomach close to the crushing clamps, which are left on to hold the stomach closed until the first row of sutures is applied. Before removing the crushing forceps the contents of the stomach are controlled by applying long, flexible rubber-covered forceps, slightly higher on the stomach, which prevent its contents from soiling the wound. After the first row of sutures has been made and the crushing forceps removed, the stomach is partially closed by an inturning suture, begun at the greater curvature, closing in toward the lesser curvature until the opening remaining is only slightly greater than the diameter of the jejunum. The jejunum is now opened opposite this point, a quarter of an inch from the first suture line, and the ordinary technic of gastro-enterostomy is completed. The opening being closed, the suture is continued as a second row over the closed portion of the end of the stomach. The first suture is now continued over the anterior portion, making two rows on the gastro-enterostomy opening, and protecting still further the closed end of the stomach by suturing over it the unopened bowel (Fig. 4).

For the last three years we have been doing the anterior Polya, the original Kroenlein instead of the posterior, bringing the loop of jejunum over the transverse colon. We abandoned the posterior Polya because of primary obstructive complications due to adhesions, to tension from gastric traction, or to late trouble from recurrence of the malignancy, with early obstruction. The anterior operation gives an easier convalescence on the average (Fig. 5). I believe that better after-results are secured by turning the bowel to the right, isoperistaltic, which was a marked feature in the earlier operations of anterior gastro-enterostomy. The point of attachment of the jejunum is approximately fourteen inches from its origin, while the opening in the stomach comes directly over the descending leg of its loop, the reverse of the Mikulicz partial closure and button anastomosis. The transverse colon naturally sags in its mid-portion; by turning the bowel from left to right it is brought to the left of the center, while the stomach delivers along its

lesser curvature, the more fixed portion of the viscus. Inasmuch as the tissues of the stomach are more or less devitalized

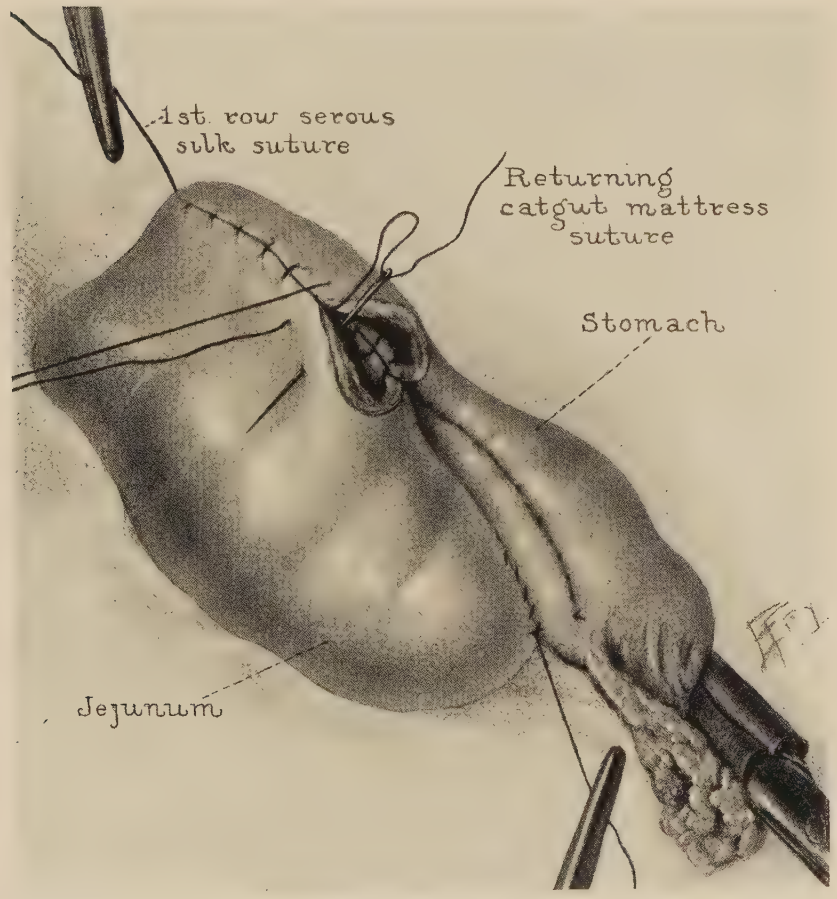


FIG. 4.—Catgut suture closing gastrojejunal opening and continuing over the closed portion of the stomach to reinforce the suture line.

by disease and more so by the operation, the suture material recommended is silk for the outer row and chromic catgut for the inner row; the silk guards against separation from delayed

healings (Fig. 6). The completed operation can be made within one hour.

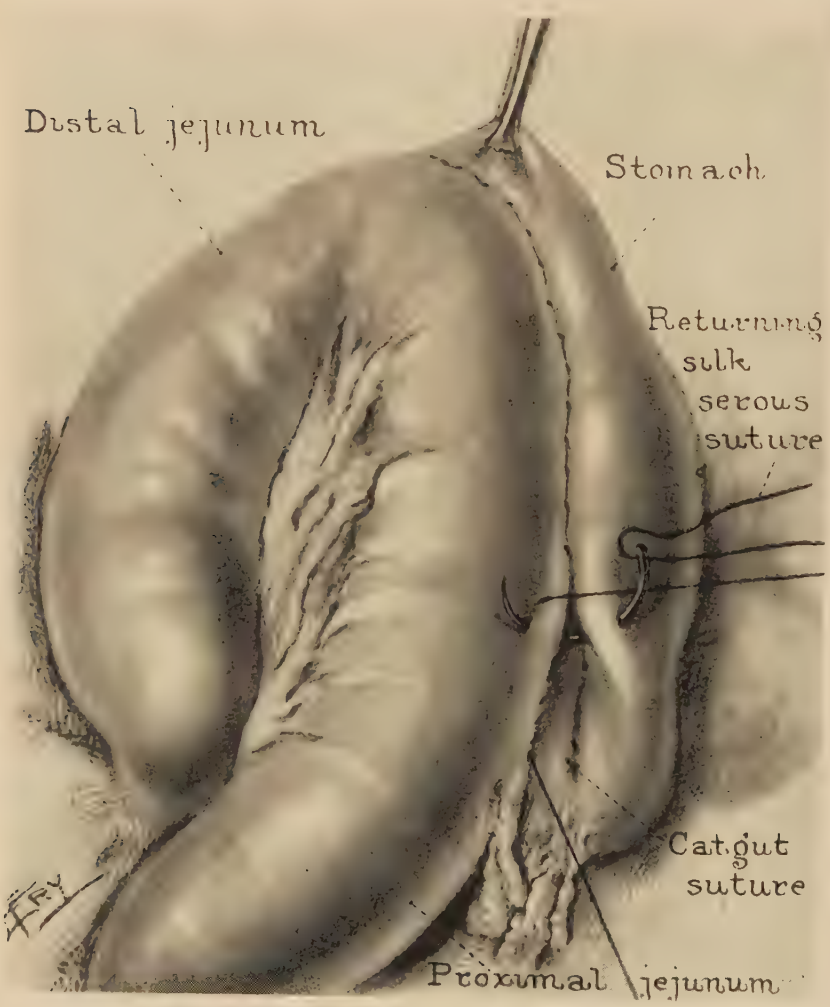


FIG. 5.—Final row—serous suture completing suture line which protects the end of the stomach with the intestine.

Our data bring the results of operation up to September 1, 1917; 427 patients were operated on during the three years

previous to September, 1917. Those who died in the hospital, and those not heard from, number 121. Those who recovered from the operation and who have been heard from number 306; 115 (37.6 per cent.) of these show three-year cures. Three hundred and thirteen patients were operated on during more than five years before September 1, 1917. Those who died in

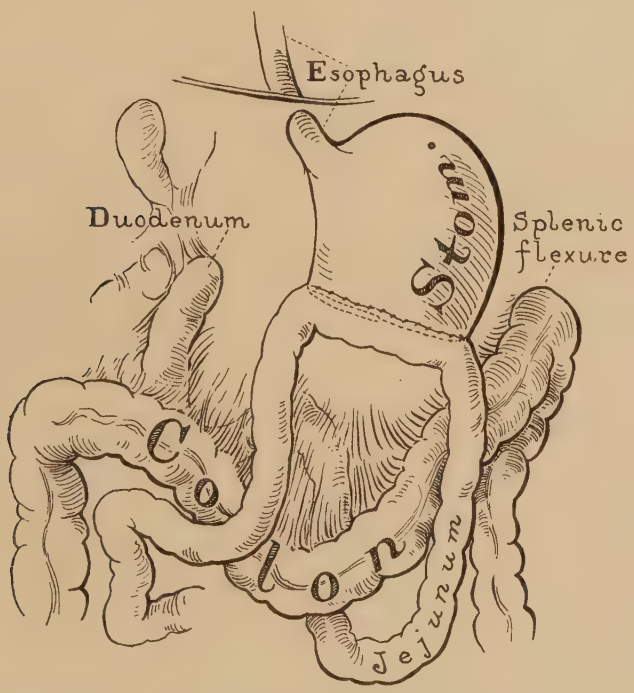


FIG. 6.—Schematic diagram. Method of attaching jejunum and stomach. Omentum not shown.

the hospital, and those not heard from, number 79. Those who recovered from the operation and who have been heard from number 234; 59 (25 per cent.) of these show five-year cures. This is a most satisfactory showing for the surgical relief of an otherwise hopeless condition which is attended by much suffering.

DISCUSSION ON THE PAPERS OF DRS. DEAVER, BALFOUR AND C. H. MAYO

Dr. Arthur D. Bevan, Chicago:

I should like very briefly to present some impression which I have had from the study of these cases in my own work. In the first place I think it is fortunate that these two subjects of ulcer and carcinoma have been discussed together, because they are really inseparable. I want first to present my impressions in regard to ulcer of the stomach and duodenum from the standpoint of the science of therapy. I, without any hesitation, should like to say that my impressions are that from the standpoint of therapy ulcer should be a medical disease, that the great majority of duodenal and gastric ulcer should be handled medically and can be successfully handled medically. I have been fortunate enough to be associated for a number of years with one of my colleagues who has a very large stomach service and who has in the hospital something over 100 stomach cases at a time; and I have had the opportunity of observing the results obtained and am satisfied that the great majority of patients with stomach and duodenal ulcer can be best handled medically, can be cured medically and can be kept cured under proper after-treatment. To my mind it is just as definitely settled that by proper medical management, ulcer of the stomach and duodenum can be cured as it is that we can cure ulcer of the leg if we place the ulcer under proper conditions. And then, if you have the opportunity of studying a large series of cases such as my colleague has had, you will see some of the results of surgical management which will surprise you. At one time recently he had under observation seven ulcers with recurrence after gastro-enterostomy had been done by the very best experts in the country. In other words, here at one time in one medical clinic were seven cases of recurrent ulcer after gastro-enterostomy had been done. Now, I am quite willing to say this, that I believe that most internal medical men push the matter of medical therapy too far, that they attempt to cover too large a ground and are not willing to give to surgery its proper due; and, personally, I think that after an ulcer has been handled medically and properly handled and still persists or develops complications, then it very properly becomes a surgical matter.

Regarding carcinoma of the stomach, the therapy here is as definitely surgical as is the therapy of carcinoma of the breast or carcinoma of the lip. On the other hand, the science of diagnosis as applied to carcinoma of the stomach must remain very largely in

the hands of our medical colleagues. And I believe that there is the one great hope that we should look forward to, that our medical colleagues will become, as some of them are becoming, very expert in the early diagnosis of carcinoma of the stomach. Within the last month I have resected three stomachs in which we had very early carcinoma, one not larger than a small epithelioma of the lower lip, one not much larger than the end of my thumb and a third of about half again that size. Now it was possible to obtain those early cases because they were in the hands of an expert diagnostician, a man who kept these cases under observation and who had applied all of the methods of diagnosis to those cases, plus this very interesting fact, that these cases are handled as carcinoma suspects the moment they do not respond to proper ulcer management. If a man is put in that clinic, and it is found that his stomach disturbance resists proper medical management, and there is a fair probability that we have a carcinoma to deal with instead of ulcer, then it is at once turned over to the surgeon, and in that way we have been able to find very early carcinoma. Early diagnosis is our hope, because carcinoma of the stomach is one of the most curable carcinomas in the body if it is early recognized.

Dr. Frank E. Bunts, Cleveland:

One word in connection with what Dr. Bevan has said. We have not had, of course, a very large series of gastro-enterostomies—between 350 and 370, but from the study of those we have come to a very clear conception of the fact that the result of gastro-enterostomy is not measured by the immediate success of the operation. These cases, in my estimation, demand the most careful attention following the operation that can be given them by the best medical men we can get. Therefore, I think it is important that when we send these cases out after operation, no matter how well they appear, how well their digestion is carried on, they be referred for careful observation, and careful regard to diet particularly, to as good a medical man as can be found.

Dr. Howard Lilienthal, New York:

I should like to ask Dr. Balfour whether the apparent advantages to humanity of being operated upon for duodenal ulcer may not be explained by the fact that the patients take better care of themselves after such operations?

Dr. Miles F. Porter, Fort Wayne:

Regarding longevity after operation for duodenal ulcer, many of us are reminded that Dr. Oliver Wendell Holmes said if one wanted

to live long he should get an incurable disease. What I rose for was especially to report a case that refers to the association of ulcer of the stomach with malignant disease, a condition with which I was never confronted before this. Briefly, the case was that of a man suffering from ulcer of the stomach. Upon opening the abdomen the diagnosis was verified, but in addition to the ulcer there were widespread adhesions which I could not describe better than to say they covered the organs of the abdomen as would a Jacksonian veil. On further observation I found a band of adhesions from the gastrohepatic omentum to the right side of the umbilicus, where it was adherent, and in this band was a nodule which I removed. The opinion of the pathologist was that it was an endothelioma, originating not from the lymph vessels but from the bloodvessels themselves. I closed the abdomen after doing a posterior gastrojejunostomy. The case was an interesting one to me and the only one of the kind I had ever seen.

Dr. Charles L. Gibson, New York:

The reader of the last paper in speaking of malignant disease of the stomach and organs has used the word "cure." To me that is a very questionable word to use regarding malignant disease. Personally I hesitate ever to use it. I would say that a case has shown ten years of recovery without recurrence, but I hesitate very much to use the word cure in malignant disease. The only way we may know the disease is cured is to have the man die and have an autopsy performed. Then failure to find carcinoma justifies you in saying it is cured. In giving to us the word cure, I think the reader of the paper should define what is meant by the term cure as he uses it. Then also in speaking of tumors of the stomach he has spoken of cure by radium. That statement of his will be widely quoted, and I should hope very much that in closing he will give his understanding of the word cure of such conditions. Here in this country particularly we have been long under the influence of the Mayo Clinic regarding the prophylaxis of carcinoma by the removal of ulcers, and I for one have shared this opinion. It is not, however, shared by a certain group of pathologists in this country and particularly abroad. I had rather hoped to hear a more detailed relationship between ulcer of the stomach and carcinoma. In New York we have a pathologist whose views are respected a great deal, who is rather discouraging the surgeons, and particularly the practitioners, from performing operations for ulcer as a possible preventive of carcinoma. He is on record in the *Annals of Surgery* in an article which attacks the validity of the Mayo statistics.

Dr. Homer Gage, Worcester, Mass.:

In all of these cases the hemorrhage was found to be contained within the sheath of the muscle, as was also the resulting abscess. In none was there any gross or microscopic evidence of thrombus in the veins.

May I be permitted to say one word *apropos* of Dr. Balfour's paper. It is, I believe, one of the very first attempts to measure the results of surgical treatment by actuarial methods, to determine accurately just what effect our surgical procedures have upon longevity. Previous attempts by the actuaries have met with so little encouragement from our larger hospital clinics that nothing has ever been done.

I think we owe a new debt of gratitude to the Mayo Clinic for permitting this investigation to be made, and I hope the work may be continued and that the results of other operations may be studied in the same way.

Dr. Balfour (in closing):

I am very glad that Dr. Deaver has made, in such a forceful way, a plea for excision of ulcer and gastro-enterostomy, because I feel that his statement will do much to establish the fact that excision of ulcer with gastro-enterostomy is the best method of dealing with lesions of the stomach and of the duodenum, provided the surgeon in his judgment believes excision is a wise technical procedure in that individual case. In some cases excision may be contraindicated because of technical difficulties. I may add, in support of what Dr. Deaver has said, a point concerning gastric hemorrhage. Occasionally we learn that patients have had serious hemorrhages after operation for ulcer of the stomach or duodenum, and in studying the results of operation I was very much surprised to find such a large number. I can make a point in respect to this group which appears to be of considerable importance. Of 2875 patients with duodenal ulcer, operated on in the Clinic in a period of twelve years up to January, 1918, 20 per cent. had hemorrhages before operation, and of these, 63 patients had bleeding after operation; 20 bled after operation who had not bled before. Twenty-five per cent. of 863 patients with gastric ulcer had bleeding before operation; 15 of these reported hemorrhage after operation and 2 patients bled after operation who had not bled before. In not one of the 83 patients with duodenal ulcer who bled after operation was excision and gastro-enterostomy done, and, with the exception of 8 of those on whom pyloroplasties were performed, the rest had gastro-enterostomy alone. Of the 17 who bled after operation for gastric ulcer only 1 had excision and gastro-enterostomy. Excision with gastro-enterostomy, there-

fore, gives almost total protection, while gastro-enterostomy alone gives only partial protection.

Further study is necessary in order to answer Dr. Lilienthal's question with regard to the possibility of the influence on longevity of the better care which patients may take of themselves after operation. I think it probable that many patients do exercise more judgment in eating after operation than before.

I was going to say something about Dr. Bevan's remarks on the medical treatment of ulcer, but will leave the discussion of Dr. Deaver in your mind. One word, however, may be added. Patients come to us averaging twelve years from the onset of symptoms. They have had, in many instances, the best medical treatment. There is no question but that the ulcer can be quieted; however, that is not the end of the story. Very few patients wish to continue for the remainder of their lives on an ulcer diet, and in the great majority the symptoms will recur.

Dr. Deaver (in closing):

Dr. Balfour's paper contains a very valuable statistical report and will have great influence for good. Particularly in connection with the work of the Actuarial Society will it be of value. Dr. Mayo's paper sounded good to me. I can endorse every point Dr. Mayo has made. It is my experience that a large percentage of gastric ulcers allowed to be treated medically fall into the cancer grave. The microscopic report of the excised ulcer is not always correct. I have operated on a number of cases in which the microscopic report was "benign ulcer," and in three years the patient was dead of cancer. The cancer cells had been overlooked. I agree with Dr. Mayo that x-ray diagnosis in the incipient case is the only reliable method outside of exploratory incision. I am here to advocate operative diagnosis. Expose the condition to the light of day and thus be certain of the condition—early interference and not late interference in this war! Very little if any good from medical treatment in chronic gastric and duodenal ulcer, absolutely no good in cancer. Very early operation means prevention of carcinomatous degeneration and the only possible means of curing carcinoma, and certainly the best known means of prolonging life and the only hope for carcinoma.

I am sorry for my friend Bevan, sorry that he cannot say as I can, "I am satisfied." I hope I have not been practising surgery all these years not to be able to say, I am satisfied as to the correct treatment of chronic ulcer and of carcinoma of the stomach. Incidentally I may remark I have had occasion to operate this winter in one case, from the clinic of which Dr. Bevan speaks, finding a most

extensive ulcer on the lesser curvature of the stomach, which was said to have been cured medically. I have saved one patient from Chicago at least! The 56 cases of perforation I have operated upon represent 5.5 per cent. of gastric and duodenal ulcers that had perforated. All had received medical treatment by many of our best medical men. I see patients die of hemorrhage of the stomach. I know medical men say they do not die. They do not often in the first attack, but they come to the surgeon having had two or three hemorrhages with a hemoglobin of 20 and a red blood count of a million or thereabouts. You have to do a transfusion if you are fortunate enough to get a blood that will mix, and you will have quite a mortality in that class. There are enough cases on record to condemn medical treatment in chronic ulcer and in cancer of the stomach. Each is a surgical condition. We have been trying to convince our medical friends of this and we are getting far better results than we did in the past, since they have accepted our teaching.

Dr. Mayo (in closing):

I think Dr. Gibson did not understand what I said about radium. It is a wonderfully effective remedy in certain forms and locations of cancer, but so far as I know its use in treatment of cancer of the stomach has been considered only palliative, to delay growth without cure.

Replying to Dr. Gibson's statement concerning the relationship of ulcer to cancer, I firmly believe there is such a relationship; that of chronic irritation, steady destruction of marginal, constantly replaced epithelium, with final exhaustion of the cell-controlling granules in an acid field. Clinicians may widely differ in their judgment as based upon observation of symptoms. Pathologists, however, should not thus differ in their interpretation of fact. The material at our laboratories is extensive and we welcome investigation by those interested in these subjects.

Concerning Dr. Deaver's paper: The treatment of ulcer by gastroenterostomy is really a surgical means of constantly applying a medical treatment. Only in the third stage of ulcer of the pylorus or duodenum is there a true mechanical condition of obstruction from contraction. Cannon shows that acid controls the contraction of the pylorus, on the other hand it is shown that alkalies relax the sphincter. These alkalies can be applied either above or below the pylorus. Alkalies from Brunner's gland area of the duodenum (first two inches) neutralize each acid bolus as delivered. Ulcer can only occur in this acid-bathed area of the duodenum, and it may occur in the gastroenterostomy opening of the jejunum, which is similarly acid. The stimu-

lus for the alkalies is food and not retained acid secretion after food has passed. An ideal gastro-enterostomy would open after all food has normally left the stomach to prevent the spasm of the pylorus causing retention of acid gastric secretion. Gastro-enterostomy lowers the acid appreciably and prevents the retention of such secretion. It therefore accomplishes the medical treatment of ulcer by overcoming the symptoms.

EXPERIMENTAL HYDROCEPHALUS[1]

By WALTER E. DANDY, M.D.
BALTIMORE, MD.

The production of all types of hydrocephalus by precise experimental methods finally lifts the idiopathic veil and reveals hydrocephalus as a disease with a clearly defined etiology and pathology. The first evidence that hydrocephalus could be experimentally produced was incorporated in an article with Dr. Blackfan in 1913.[2] It was demonstrated that when a tiny obstructing body was introduced into the aqueduct of Sylvius of a dog, all the cerebral ventricles proximal to the occlusion became dilated; distally, the size of the fourth ventricle was not changed.

The following year, Thomas[3] published additional experimental evidence that hydrocephalus was caused by obstruction. Following the injection of aleuronat granules into the lateral ventricles, the iter became plugged; organization of the granules resulted in total occlusion of the opening and hydrocephalus followed.

[1] These studies have been conducted in the laboratories of Professor Halsted. His suggestions have been invaluable in the development of many new problems in a virgin experimental field. The success of many of the crucial experiments is in large part due to consultations with him.

[2] Dandy, W. E., and Blackfan, K. D.: Internal Hydrocephalus: An Experimental, Clinical and Pathological Study, Jour. Am. Med. Assn., 1913, lxi, 2216. Also, Am. Jour. Dis. Child., 1914, viii, 406; Am. Jour. Dis. Child., 1917, xiv, 424; Beitr. z. klin. Chir., 1914, xciii, 392.

[3] Thomas, W. T.: Experimental Hydrocephalus, Jour. Exper. Med., 1914, xix, 106.

As early as the middle of the eighteenth century, Haller, Brunner and Littré looked upon an obstruction to the outflow of the ventricular contents through the pituitary body as the cause of hydrocephalus. Such a theory of obstruction can only be regarded as fanciful, since vapor and not fluid was at that time regarded as the normal content of the ventricles; the pituitary body was erroneously regarded as the main avenue of escape for the vapor in the ventricles.

Magendie (1825) first described an anatomical obstruction at the base of the brain in several cases of hydrocephalus, but he was not entirely convinced that the obstruction was the cause, because he regarded the pia as the source of all cerebrospinal fluid. Reasoning from this viewpoint he expected an obstruction to cause dilatation of the ventricles posterior rather than anterior to the obstruction. Throughout his publications he was much perplexed by his inability to correlate these pathological findings with his physiological conceptions. He never suspected the choroid plexus as the organ of secretion of the cerebrospinal fluid. The findings, therefore, were entirely empirical. Despite his mistaken interpretations, the cases stand as probably the first in which a mechanical obstruction was described and considered to have a bearing on the disease.

Two additional discoveries of the greatest importance were made by Magendie, without which any consideration of the etiology of hydrocephalus would still be useless. He first established the fact that fluid and not air or vapor fills the ventricles and the subarachnoid space in the living; and he discovered the foramen of Magendie, an opening which established communication between the ventricular system and the subarachnoid space.

Hilton (1860) did a great deal more to confirm the view that obstruction was the cause of hydrocephalus. He accurately described and made drawings of obstructions in three cases of hydrocephalus; in one a stenosis was in the aqueduct of Sylvius and in two cases the foramen of Magendie was closed by a scar. In each, hydrocephalus resulted proximal to the obstruction. Numerous examples of obstruction have since been added, but

with little additional influence in overcoming a very strong prejudice against the acceptance of the obstructive theory of hydrocephalus.

Opposed to the obstruction theory was the impressive argument that in most cases of hydrocephalus there was no obstruction, and even no cause of any kind could be found. Those who held this negative opinion looked upon obstruction in the remaining cases as purely incidental and in no way etiological; all cases of hydrocephalus were considered idiopathic.

A third school conceived two entirely different types of hydrocephalus: (1) in which an obstruction produced the disease, and (2) in which no cause could be found. The second type they regarded as idiopathic.

The existence of the foramen of Magendie is even now disputed by eminent authorities. Magendie himself admitted, as is now well recognized, that his foramen is not present in dogs and other animals. Why then should it be significant for man? Many still consider this foramen an artefact, as other foramina which have been described, have proved to be.

In 1855 Luschka made a discovery which clarifies much of the earlier confusion and makes a theory of obstruction tenable. He discovered two additional openings between the fourth ventricle and the subarachnoid space, making with the foramen of Magendie, three in all. These openings, now known as the foramina of Luschka, are present in all animals; their presence makes it clear why the foramen of Magendie may be absent without hydrocephalus.

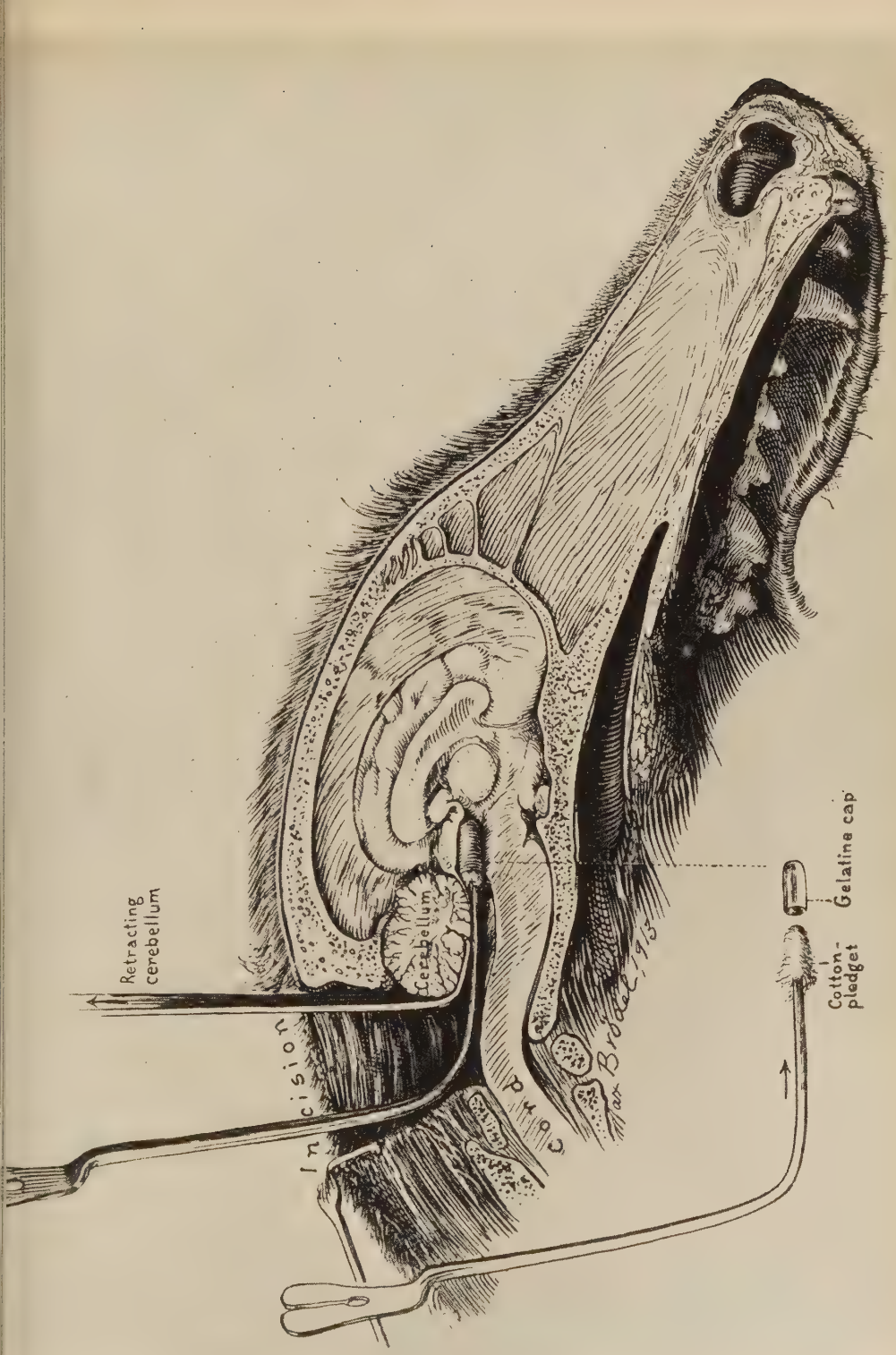
But the knowledge of the anatomy of the cerebrospinal spaces and the circulation of the cerebrospinal fluid in these spaces has been very vague. If the fundamental facts are so uncertain, any discussion of the etiology of the disease must be fruitless. The experiments here presented will clear any uncertainty about the grosser anatomy of the cerebrospinal spaces as well as the normal circulation of the cerebrospinal fluid and the results following the interference with the normal pathways for this circulation.

A very simple experiment will demonstrate the existence of a communication between the ventricles and the subarachnoid space. If phenolsulphonephthalein or any other inert colored solution is injected into a lateral ventricle it will quickly appear in the spinal fluid removed by lumbar puncture. The location of the communication can be demonstrated by the exclusion of the third and both lateral ventricles, limiting the possibility of communication to the fourth ventricle. If the aqueduct of Sylvius is occluded experimentally or, if, in a patient, it is occluded by any pathological process, the colored solution will not appear in the spinal fluid following an injection into a lateral ventricle. This limits the location of the communication to the fourth ventricle. This communication is by the foramina of Luschka and Magendie, and can be demonstrated in any brain at necropsy. At any cerebellar operation the foramen of Magendie can easily be seen. So necessary is this communication that when absent, as indicated by the phenolsulphonephthalein test, an internal hydrocephalus invariably must result. The presence of a communication can be demonstrated by the introduction of air into the lateral ventricle. The air will pass externally and appear in the cisternæ and the sulci over the cerebral hemispheres. The air can be photographed in the *x*-ray,[1] and it can even be seen passing through the foramen of Magendie into the cisterna magna if one makes a fluoroscopic examination.[2] By these simple tests the possibility of producing an artefact is out of question. The remaining anatomical and physiological facts will be deduced from the succeeding experiments.

Hydrocephalus Produced by Placing an Obstruction in the Aqueduct of Sylvius. These experiments were conducted on dogs, under ether anesthesia. The midportion of the squamous occipital bone, including the posterior margin of the foramen magnum, was removed with rongeurs and the dura opened in a

[1] Dandy, W. E.: Ventriculography following the Injection of Air into the Cerebral Ventricles, Ann. Surg., July, 1918.

[2] Dandy, W. E.: Fluoroscopy of the Cerebral Ventricles, Bull. Johns Hopkins Hosp., February, 1919.



G. 1.—Mid-sagittal view of a dog's head to illustrate method of procedure in occluding the aqueduct of Sylvius. By this method hydrocephalus results, involving the third and both lateral ventricles.

stellate fashion. By gently elevating the cerebellum, the roof of the fourth ventricle was exposed, perforated, and a tiny piece of cotton cautiously pushed forward on the point of a fine graduated carrier. It was passed over the medulla and pons until it glided into the aqueduct of Sylvius, where it was deposited by withdrawal of the carrier. An improved technic of this procedure consists in inclosing the cotton in an oiled gelatin capsule, which soon dissolves in the cerebrospinal fluid (Fig. 1). The aqueduct of Sylvius is fairly easily recognized by the sense of touch imparted to the finger which is directing the entry of the obstruction. The constriction at the terminus of the funnel-like approach from the wide fourth ventricle denotes the entrance to the narrow aqueduct of Sylvius. The iter is, moreover, at a constant measured distance from the posterior border of the cerebellum. If the head is not held in a strictly median position, it is easily possible to make a false passage into the contiguous soft brain tissue, with permanent injury to the pyramidal tract and the nuclei of the cranial nerves.

By producing hydrocephalus with a tiny obstruction in the aqueduct of Sylvius, the etiological rôle of an occlusion is absolutely established. Being a single precise process and involving no neighboring structures, other possible explanations of the resultant hydrocephalus are precluded. When an obstruction is present in any part of the ventricular system, the ventricles always dilate anterior to the occlusion. Following occlusion of the aqueduct of Sylvius, therefore, the third ventricle and both lateral ventricles become distended. The size of the fourth ventricle remains unchanged.

Fig. 2 shows sections of dog's brain one month after the obstruction was introduced. Doubtless, for some time after the cotton was placed in the iter, there was only a partial occlusion, which became complete with organization of the foreign body. The animals become lethargic and there is intermittent vomiting. Ventricular dilatation is accompanied by a corresponding degree of cerebral destruction. The experiments were all performed on dogs after union of the sutures, so that enlargement of the head

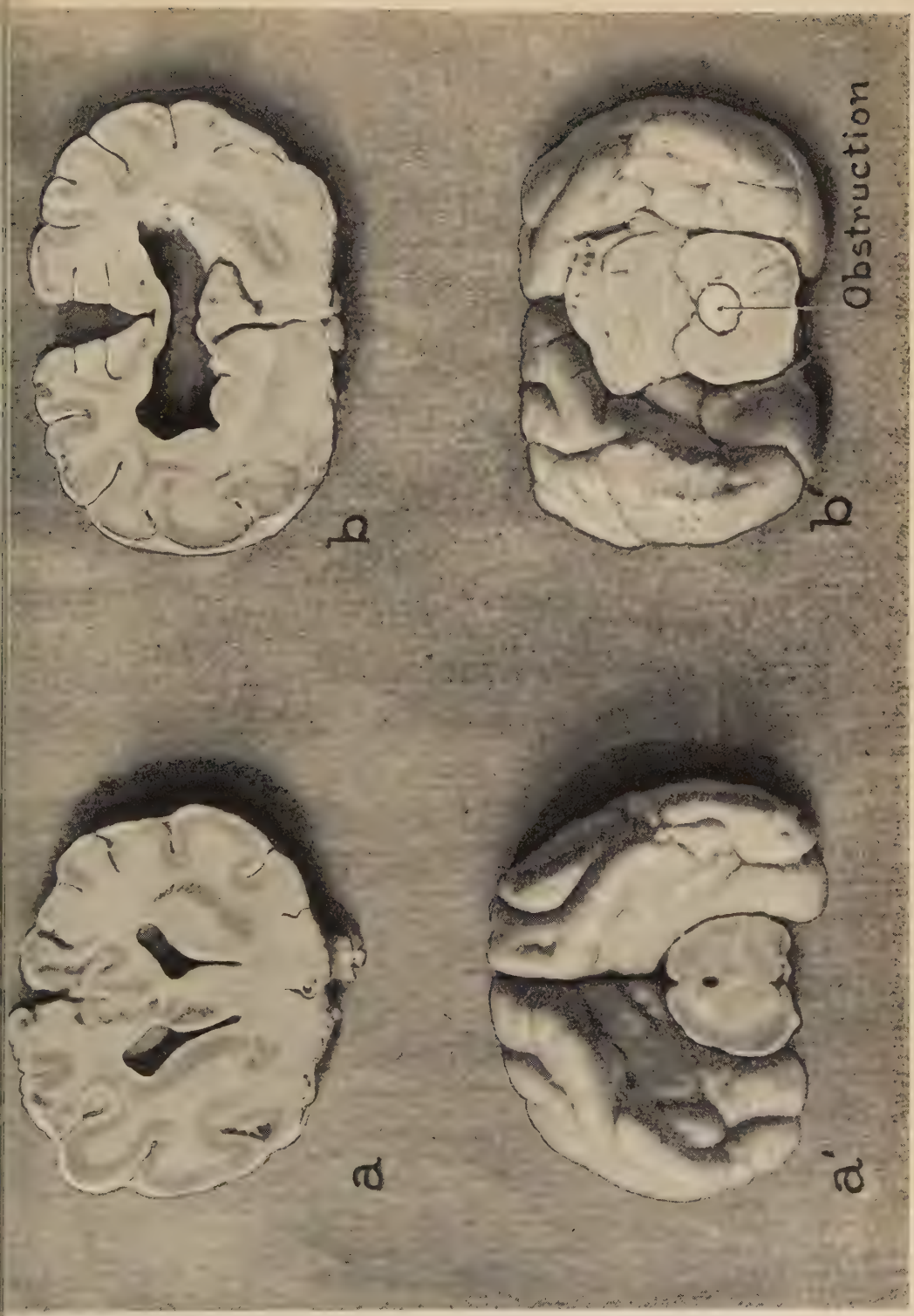


FIG. 2.—Hydrocephalus of one month's duration resulting from an occlusion placed in the aqueuct of Sylvius (*b* and *b'*), as demonstrated in Fig. 1. *a* and *a'* are sections of a normal dog's brain at evels corresponding to *b* and *b'*. Note the fusion of both lateral ventricles (in *b*) following atrophy f the septum lucidum. The obstruction is shown in the iter (*b'*).

could not develop. In animals operated on at birth or soon thereafter, the characteristic hydrocephalic enlargement of the head will necessarily be an outstanding feature which cannot be duplicated when the animal is older.

From this series of experiments we have absolute evidence (1) that *cerebrospinal fluid forms in the cerebral ventricles;* (2) that *absorption in the ventricles is at least less than the production;* (3) that *the aqueduct of Sylvius is a necessary outlet from the third and both lateral ventricles;* and (4) that *there are no collateral channels which assume the function of the iter when it is occluded.*[1]

Unilateral Hydrocephalus Produced by Occluding One Foramen of Monro. Since the third and both lateral ventricles distend following occlusion of the aqueduct of Sylvius, it is reasonable to expect that an obstruction of one foramen of Monro will produce enlargement of the affected ventricle, that is, a unilateral hydrocephalus.

Spiller[2] has published a case of unilateral hydrocephalus with occlusion of one foramen of Monro. The occlusion of the foramen was due to a cicatrix, he thought, of tuberculous origin. I have had under observation a case in which a pedunculated glioma was suspended in the left lateral ventricle and periodically closed one foramen of Monro. With each occlusion severe headaches, vomiting, partial hemiplegia ensued. Following each attack there was complete subsidence of the signs and symptoms. Doubtless the free intervals were synchronous with the period in which the foramen of Monro was open. Gradually the attacks became more frequent and more violent, and one week before death a final attack began and terminated in death. The affected ventricle was greatly enlarged; the foramen of Monro was completely filled by the tumor which had been forced into the foramen and there became impacted. Part of this obstructing tumor

[1] For the data concerning the place and manner of formation and absorption of cerebrospinal fluid, the reader is referred to the article previously cited in the American Journal of the Diseases of Children.

[2] Two Cases of Partial Internal Hydrocephalus from Closure of the Interventricular Passages, Am. Jour. Med. Sc., 1902, p. 44. Also Jour. Am. Med. Assn., 1907 vol. xlviii.

could be dislocated, leaving the foramen of Monro only partially occluded.

The foramen of Monro of a dog can be blocked by inserting either a small piece of fascia or peritoneum (Figs. 3 and 4). Eventually the transplanted tissue becomes incorporated in a

FIG. 3.—To demonstrate the method of introducing a piece of fascia into the foramen of Monro of a dog's brain. A transcortical incision into the ventricle at this point also permits complete choroid plexectomy of one lateral ventricle. Being well posterior, injury to the pyramidal tract is also avoided.

cicatrix and total occlusion of the foramen results. The foramen of Monro is reached for this procedure by a transcortical incision which opens into the body of the lateral ventricle well posteriorly. The opening in the brain is maintained by an open nasal speculum. Through this window the foramen of Monro can be seen well forward, where the choroid plexus makes a sharp turn into

the third ventricle. The margins of the foramen are scarified before introducing the piece of peritoneum or fascia. The cortical defect is sutured with fine silk. A unilateral hydrocephalus develops on this side (Figs. 5 and 6). There is, of course, no change in the opposite lateral ventricle. Curiously, the cortical opening heals without formation of a ventricular fistula or hernia, despite the total occlusion of the foramen of Monro and the resulting accumulation of cerebrospinal fluid. The healing is similar to the

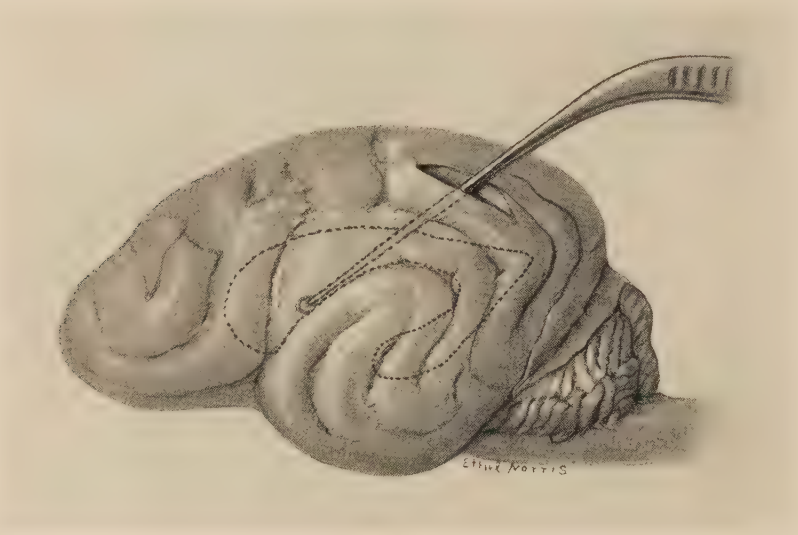


Fig. 4.—Lateral view of a dog's brain to show method of occluding the foramen of Monro. The outline of the lateral ventricle is shown by a dotted line.

spontaneous closure of an opening made in the corpus callosum for the attempted relief of internal hydrocephalus. It is almost impossible to maintain an opening in a ventricle.

Occlusion of the Foramen of Monro after Removal of the Choroid Plexus. The entire choroid plexus of one lateral ventricle can be removed through the same transcortical incision that is made in order to plug the foramen of Monro. If choroid plexectomy is to be done, the incision in the cortex should be

FIG. 5.—Photograph of sections of a dog's brain in which a unilateral hydrocephalus has followed occlusion of the left foramen of Monro. The right ventricle is normal.

FIG. 6.—Views of another brain with unilateral hydrocephalus. Note the thinning of the cortex as contrasted to the normal (right). The scar in the cortex (upper photograph) is due to closure of the transcortical incision. A ventricular fistula never follows opening of the ventricle.

even more posteriorly—into the posterior horn of the ventricle—so that the descending horn and the body of the lateral ventricle can be directly illuminated at the same time. The choroid plexus can then be seen through its entire extent. The choroid plexus is picked up with delicate forceps at the foramen of Monro and stripped from its attachment to the velum interpositum as far as

FIG. 7.—Section of a dog's brain three months after the left foramen of Monro was blocked, *but in which the entire choroid plexus of this ventricle was removed.* The left ventricle is a mere slit, the right ventricle is normal. The transcortical defect is shown in the left side. Contrast the left ventricle in Figs. 5, 6 and 7. In all, the foramen of Monro has been occluded but removal of the choroid plexus (Fig. 7) prevents hydrocephalus from forming. This is absolute evidence that the choroid plexus secretes cerebrospinal fluid and that ependyma takes no part in its formation.

the glomus. The tip of the choroid plexus in the descending horn is then picked up and stripped in a similar manner until the glomus is reached. In this way the entire choroid plexus can be removed in one piece. Numerous tiny bloodvessels enter the choroid plexus through its narrow edge of attachment to the ventricular wall. The vessels, however, are quite small, and the

slight bleeding can be easily controlled by pledgets of cotton moistened in warm saline solution.

If the entire choroid plexus is removed and the foramen of Monro is blocked at the same time, the ventricle becomes obliterated (Fig. 7). A marked contrast is produced by blocking the foramen of Monro on the opposite side without removal of the choroid plexus. Both foramina of Monro being occluded, a collapsed ventricle results on the side from which the choroid plexus has been removed, but the ventricle becomes greatly enlarged on the side in which the choroid plexus is intact. From these experiments *we have the only absolute proof that cerebrospinal fluid is formed from the choroid plexus. Simultaneously it is proved that the ependyma lining the ventricles is not concerned in the production of cerebrospinal fluid.*

Extirpation of the Choroid Plexus from Both Lateral Ventricles Followed by Occlusion of the Aqueduct of Sylvius. In a few dogs the choroid plexus was extirpated from both lateral ventricles and at the same operation or shortly thereafter the aqueduct of Sylvius was occluded. In these animals hydrocephalus developed and involved both lateral ventricles and the third ventricle (Fig. 8). There was, however, a pronounced retardation in the development of the hydrocephalus when compared with that which follows the introduction of a similar occlusion, but without a bilateral choroid plexectomy. Hydrocephalus develops because the amount of cerebrospinal fluid which is produced from the choroid plexus of the third ventricle and which cannot escape through the closed aqueduct of Sylvius is still greater than the absorption which is possible from the three ventricles. The open foramina of Monro permit the fluid which is formed in the third ventricle to pass freely into and distend both lateral ventricles. We have tried removal of the choroid plexus of the third ventricle, but this has proved unsuccessful. The veins of Galen must be removed together with the roof of the third ventricle to obtain all the choroid plexus from the third ventricle. The animals always succumb to the effects of intraventricular hemorrhage

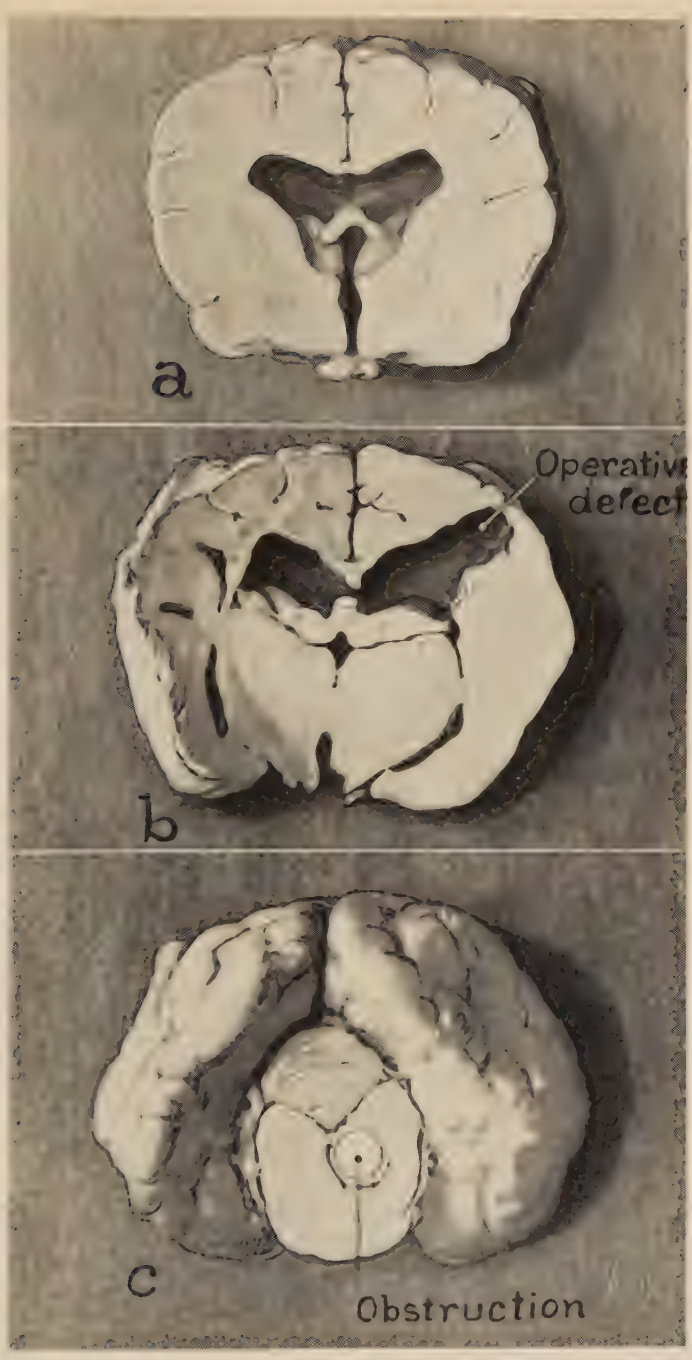


FIG. 8.—Sections of a dog's brain showing hydrocephalus of five weeks' duration resulting after occlusion of the aqueduct of Sylvius, *but in which the choroid plexus of both lateral ventricles was removed* at the same operation. The accumulated cerebrospinal fluid forms solely from the choroid plexus of the third ventricle. Since both foramina of Monro are patent the distention of the lateral ventricles is a necessary sequel to the obstruction in the aqueduct of Sylvius. The remains of the septum lucidum are still evident in *b*. The obstruction (*c*) is slightly beyond the midline but effectively closes the iter.

if this operation is attempted. It would doubtless be possible (though we have not done it) to obliterate both lateral ventricles by occluding both foramina of Monro and later to obstruct the aqueduct of Sylvius, thereby producing enlargement of the third ventricle alone.

Hydrocephalus Following Ligation of the Vena Magna Galeni. Hydrocephalus has often been attributed to an occlusion of the vena magna Galeni or sinus rectus, or both, but in most instances the evidence has been inconclusive. Hydrocephalus forming in this way would be analogous to ascites following stenosis of the inferior vena cava. In either instance the accumulation of fluid indicates an inadequate collateral circulation. The vena magna Galeni drains the venous blood from the entire interior of the cerebrum, and these vessels probably being largely terminal have but little communication with the extracerebral veins. After the formation of the vena magna Galeni, however, numerous channels establish a free anastomosis between the intra- and extracerebral venous circulation. The basilar, superior cerebellar, temporal, internal occipital, posterior corpus collosal, and other veins bring the two systems into free communication.

Whether hydrocephalus results from venous stasis depends entirely upon the amount of collateral circulation which can develop. If both jugular veins are compressed in a dog, the amount of cerebrospinal fluid is immediately and rapidly increased. This increased production of fluid, however, disappears within a few minutes as the collateral venous circulation becomes established.

As early as 1768 Wyeth looked upon venous obstruction as being an important factor in the production of hydrocephalus. Magendie (1825) records a case of thrombosis of the vena magna Galeni and sinus rectus. The symptoms were only of a week's duration, an interval too short to give a demonstrable dilation of the ventricles. As the determination of excess quantities of fluid postmortem is very unsatisfactory and untrustworthy, the diagnosis of hydrocephalus may be questioned. In the vast

majority of cases in which venous stasis is regarded as the cause of hydrocephalus, a tumor has been in the corpora quadrigemina, mesencephalon, corpus pinale, or elsewhere in the vicinity of the vena magna Galeni. Owing to the size of brain tumors, one is not justified in assuming that the hydrocephalus is due to a specific occlusion of the bloodvessels, especially since in the mid-brain the aqueduct of Sylvius soon becomes obstructed by tumors; and this we know always results in hydrocephalus.

Undisputed increase of cerebrospinal fluid from a vascular occlusion can be assured only when a pure vascular obstruction exists, as in thrombosis. The authentic cases in which thrombosis of the veins of Galen or straight sinus has caused hydrocephalus are few, but apparently definite. Newman[1] (1882) reports a case, and Browning[2] (1887) another. Undoubtedly, others have been described but have escaped notice. A few cases of a sharply localized thrombosis of the vena magna Galeni with hydrocephalus are sufficient to establish the causative relationship.

Experimentally, we have been able to establish this point with accuracy. In a series of ten dogs we have ligated the great vein of Galen and the straight sinus in varying places. In a single instance hydrocephalus resulted, and in this case the obstruction was placed at the point of origin of the large vein of Galen (Fig. 10). In the remaining 9 cases the size of the ventricles was not altered. In other words, hydrocephalus results when an occlusion of the great vein of Galen is located at its origin, but not when the obstruction is placed more distally or along the straight sinus. Above the origin of the great vein of Galen there is apparently sufficient venous collateral circulation to overcome the effects of the obstruction. In dogs, the vein of Galen can be fairly readily exposed at operation by retracting the occipital lobe and carefully dissecting the vein from its bed over the mesen-

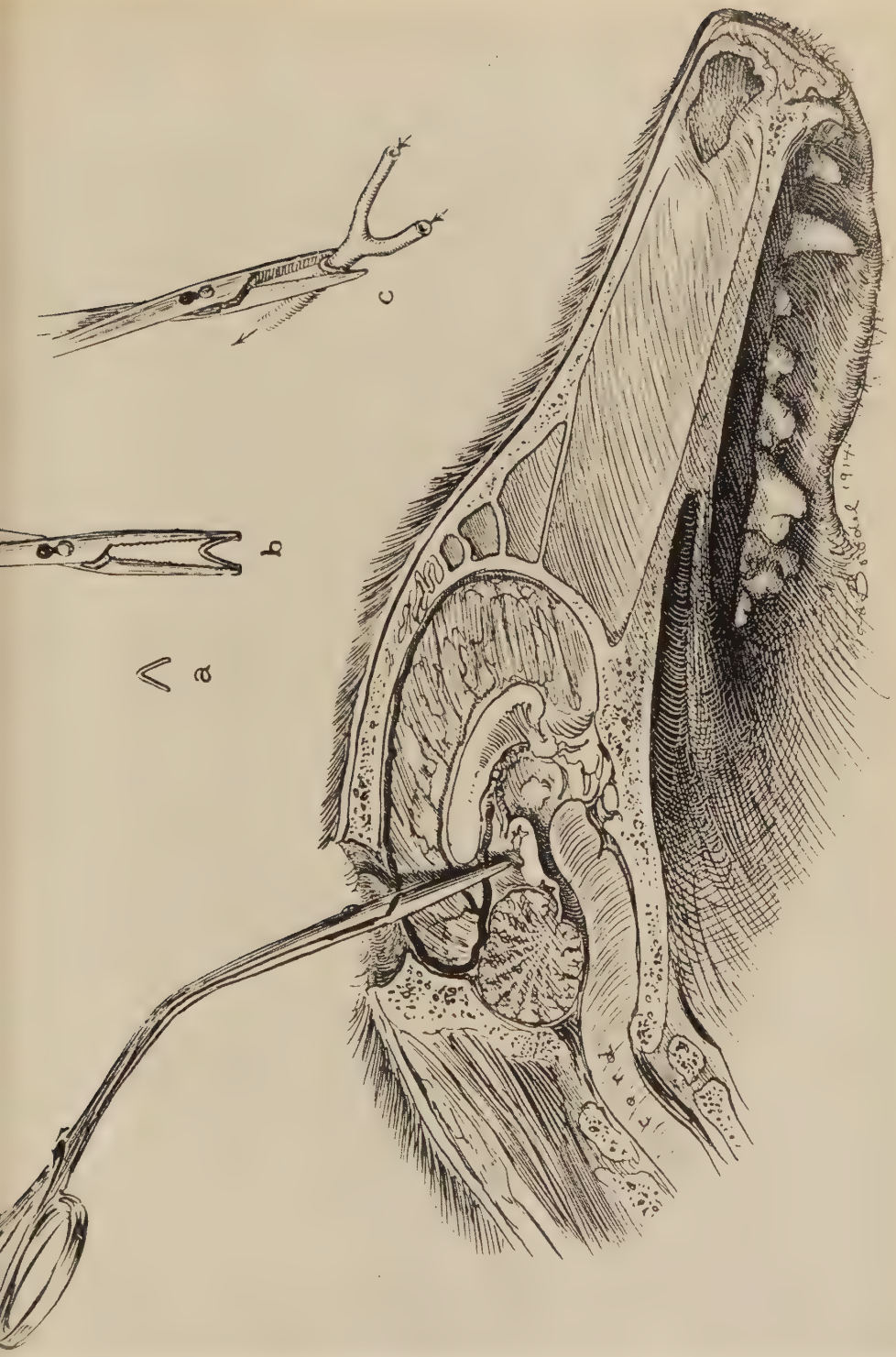
[1] Two Cases of Ventricular Hydrocephalus; One Due to Pressure on the Sinuses by a Tumor in the Cerebellum, the Other to Thrombosis of Galen's Vein, Glasgow Med. Jour., 1882, iii, 161.

[2] A Case of Internal Hydrocephalus Due to Disease (Thrombotic) in the Wall of the Straight Sinus, Jour. Nerv. and Ment. Dis., 1887, xli, 260.

cephalon. For a very low occlusion, the splenium of the corpus callosum must be divided. The beginning of the vein of Galen can then be seen just above the pineal body. Ligation of the vessels by a ligature is difficult because of the depth of the wound. The same result is accomplished by compressing a small silver clip over the vessel at the desired point (Fig. 9).

The animal in which hydrocephalus resulted, presented no symptoms which distinguished it from the others. The diagnosis of hydrocephalus was made solely from the postmortem examination. The hydrocephalus developed very much more slowly than that following an occlusion of the aqueduct of Sylvius. In hydrocephalus resulting from venous stasis, all the cerebral ventricles and the aqueduct of Sylvius are enlarged. In gross appearance hydrocephalus so produced is exactly similar to that in the hitherto so-called "idiopathic" or communicating hydrocephalus. The aqueduct of Sylvius, the foramina of Monro, Magendie and Luschka, all become enlarged, because the accumulation of fluid is due to overproduction, and there is no obstruction to localize the dilatation. This type of hydrocephalus is different from other chronic types. It is due to overproduction of cerebrospinal fluid, whereas other forms are due to a diminished absorption. Possibly this type of hydrocephalus may subsequently be differentiated clinically, but we have had no case under observation. It must be quite rare, for from the pathological examinations of over thirty cases of hydrocephalus we have not encountered a single occlusion of the great vein of Galen or of the straight sinus.

Channels for the Circulation of Cerebrospinal Fluid in the Subarachnoid Space. Before considering the cause and the experimental production of the communicating type of hydrocephalus, it will add clearness to briefly consider the normal channels through which the cerebrospinal fluid is distributed. As heretofore mentioned, all the cerebrospinal fluid in the ventricular system must pass into the subarachnoid space through the three basal foramina of Luschka and Magendie. Of these foramina, not infrequently one or even two may be obliterated;



9.—Illustration of the method of procedure in ligating the great vein of Galen in a dog. A silver clip laced astraddle of the vein, which is very deeply situated. Compression of the clip occludes the vessel.

FIG. 10.—Hydrocephalus of three and one-half months' duration, resulting from a ligature on the vena magna Galeni near its origin. The aqueduct of Sylvius is also enlarged. This form of hydrocephalus results from an overproduction of fluid; all other forms from a diminished absorption of fluid.

and the third alone will maintain adequate communication. The arrangement of the channels of the subarachnoid space is in a general way that of the trunk and branches of a tree. The basal cisternæ—forming a water bed under the brain stem and artificially subdivided into the cisterna cerebellomedularis (cisterna magna), cisterna pontis, cisterna interpeduncularis, cisterna chiasmatis — are homologous to the trunk of the tree. From these cisternæ fluid is distributed along the major branches of the subarachnoid space which accompany the blood-vessels and traverse the sulci between the cerebral convolutions. The exact number and the relations of the smaller channels has not yet been worked out. The closure of large areas of the subarachnoid space over either cerebral hemisphere, apparently produces no general effects on the absorption of cerebrospinal fluid because the main channels are intact and there is a sufficient absorbing area remaining to easily compensate for this loss. If, however, the cisternæ are obliterated, the trunk is occluded and fluid cannot reach the branches of the subarachnoid space which spread over both cerebral hemispheres. There are no collateral channels which can reëstablish this circulation of cerebrospinal fluid, consequently cerebrospinal fluid cannot reach the cerebral subarachnoid spaces where most of the absorption takes place. An obstruction in the cisternæ is comparable to transection of the trunk of a tree. Whereas death of the tree results from division of the trunk, only local effects result from the destruction of many branches. Occlusion of the cisternæ results in hydrocephalus; many of its branches may be obliterated without hydrocephalus.

The circulation of cerebrospinal fluid can be strikingly demonstrated by substituting India-ink for cerebrospinal fluid in an anesthetized dog. The ink follows the normal channels forming the subarachnoid space; by sacrificing the animals at varying intervals of time after the injection, the various stages of distribution can be observed. Almost immediately all the cisternæ are filled with ink, the cerebellar subarachnoid space also rapidly fills, owing to its intimate relationship with the

cisterna magna. Gradually filaments of ink fill the sulci over all surfaces of both cerebral hemispheres; the sulci radiate from the cisterna and appear to anastomose over the cerebral hemispheres. In a series of animals it required from forty-five to seventy-five minutes to reach the most remote spaces along the longitudinal sinus. Very artificial results follow injections of fluids under pressure. Incidentally, if it takes such a long period of time to reach the longitudinal sinus, the hypothesis that absorption occurs through special structures along the longitudinal sinus, is immediately vitiated, because normally the rate of absorption from the subarachnoid space is 20 to 25 per cent. an hour (by the phenolsulphonephthalein test). Therefore, 20 to 25 per cent. absorption has already occurred before the longitudinal sinus has been reached by the dye. Such an hypothesis is also precluded by the fact that a considerable part of this absorption takes place from the spinal subarachnoid space.

The Cause of Hydrocephalus with Communication. The type of hydrocephalus in which no pathology has been found and which has been regarded as idiopathic hydrocephalus is characterized by dilatation of all the cerebral ventricles and by a free communication between the ventricular system and the subarachnoid space. By the phenolsulphonephthalein test this type of hydrocephalus has been shown to be caused by a diminished absorption from the subarachnoid space. It will be remembered that fluid normally forms in the cerebral ventricles but does not absorb there; that absorption takes place only in the subarachnoid space. Therefore, the aqueduct of Sylvius and the foramina of Luschka and Magendie must be patent to maintain the balance between the production and the absorption of cerebrospinal fluid. In communicating hydrocephalus there is a greatly reduced absorption, despite a perfectly free communication. By the phenolsulphonephthalein tests the absorption from the subarachnoid space has been shown to be only 10 per cent. in two hours, or about one-fifth of the normal rate of absorption from this space. The absorption of this dye from the ventricles in communicating hydrocephalus is also about one-

fifth of the normal. The ventricular absorption, however, is but a reflection of the absorption from the subarachnoid space, since the absorption of ventricular fluid occurs only after it reaches the subarachnoid space.

In a recent paper[1] this type of hydrocephalus was shown to be due to adhesions which obliterated the cisternæ. The adhesions were not present over the entire brain, but mainly at the base and around the incisura tentorii; that is, where the major effects of meningitis are usually distributed. Obliteration of the cisternæ or a circle of adhesions around the mesencephalon prevents cerebrospinal fluid from passing to sulci over the cerebral hemispheres. Absorption of cerebrospinal fluid is a general process which takes place from the entire subarachnoid space. With the major part of the subarachnoid space mechanically eliminated by an obstruction in the trunk of the subarachnoid tree, the area in which absorption of cerebrospinal fluid can occur is limited to about one-fifth of the normal amount. Consequently hydrocephalus results from a greatly diminished absorption. In reality, therefore, communicating hydrocephalus is caused by an obstruction, and differs from the so-called obstructive hydrocephalus only in the location of the obstruction. To disclose adhesions and obliteration of the subarachnoid space, the brain must be carefully removed and studied during its removal. A subsequent examination of the brain reveals but little, because the adhesions have all been liberated by removal of the brain and the gross appearance of thickened pia-arachnoid is not striking after fixation. A striking demonstration of the location of the obstruction will no doubt result by injecting colored solutions into the spinal canal under minimal pressures. The colored injection mass, of course, will stop at the obstruction. This color contrast will be seen in one of the cases of experimental hydrocephalus which will appear in the following pages. A demonstration equally striking can be shown in the living by intraspinous air injections. These observations will appear in a subsequent paper.

[1] Loc. cit., Am. Jour. Dis. Child., 1917, xiv, 424.

These pathological findings are in perfect harmony with the appearance of the brain at operation. At operation, in both the obstructive and the communicating types of hydrocephalus, the sulci over the hemispheres are seen to be shallow and contain but little fluid. If the subarachnoid spaces were not obstructed at the regions mentioned, fluid would accumulate in the sulci and cause their dilatation up to the point of obstruction, just as bile accumulates up to the obstruction in the common bile duct. There is but little fluid in the cerebral sulci because the barrier of adhesions has prevented the cerebrospinal fluid from reaching the cerebral hemispheres. As mentioned previously, the physiological tests (by phenolsulphonephthalein) show about one-fifth of the normal absorption from the subarachnoid space, apparently indicating a reduction in the subarachnoid space to one-fifth of its normal area.

The Experimental Production of Communicating Hydrocephalus. The absolute test that the pathological findings described for communicating hydrocephalus are correct lies in the ability to reproduce this disease in animals. The effects of meningitis are so diffuse that differences of opinion in the interpretation of the findings are permissible. A single, sharply defined experimental lesion eliminates speculation. The experimental methods which I have used were suggested by the results of the physiological phenolsulphonephthalein tests, and were developed before any pathological material had been obtained.

The object of the experiments is to eliminate the subarachnoid space above the incisura tentorii, and thereby to exclude the entire cerebral subarachnoid space from participation in the absorption of the cerebrospinal fluid. A glance at the intracranial topography will show that the only communication between the posterior and middle cranial fossæ is through the incisura tentorii, through which the mesencephalon passes. Except for this opening, the tentorium cerebelli acts as an impermeable diaphragm, which divides the cranial chamber into two cavities. We propose to produce adhesions around the entire circumference of the midbrain where it traverses the incisura tentorii (Fig. 11).

This will obliterate by a circular band the subarachnoid space surrounding the midbrain. The principal part of the subara-

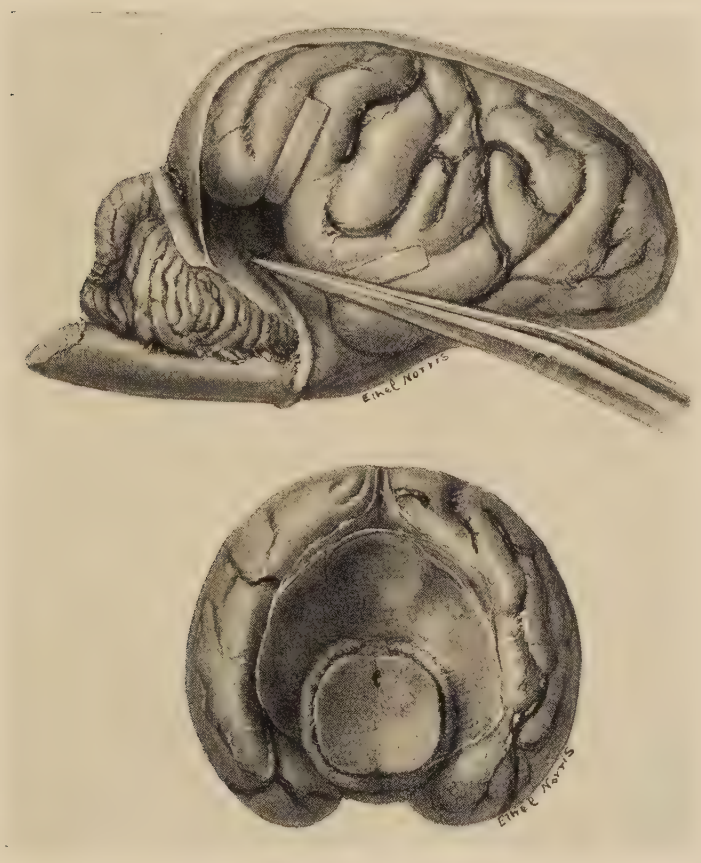


FIG. 11.—Drawings by Miss Norris to show method of placing a perimesencephalic band in position, and also to show its approximate location. The lower figure shows the band in place. Adhesions form between the brain and the gauze and occlude the cerebrospinal spaces, including the cisterna. "Communicating" hydrocephalus results from this procedure.

chnoid space which will be obstructed by this procedure will be the cisterna under the midbrain. This cisterna is the part of the main trunk through which all the cerebrospinal fluid must pass.

In other words, if the experiment is successful, cerebrospinal fluid cannot pass beyond the posterior cranial fossa into the middle, and thence subsequently also the anterior, cranial fossæ. *All cerebrospinal fluid enters the cisterna magna from the fourth ventricle,* but the experimental obstruction prevents it from passing into the cisterna interpeduncularis and cisterna chiasmatis. The cerebrospinal fluid therefore cannot reach the subarachnoid space which forms a mantel over both cerebral hemispheres. By eliminating the entire cerebral subarachnoid space the amount of absorption of cerebrospinal fluid should be tremendously reduced and hydrocephalus should follow.

This sharply defined area of adhesions can be produced by encircling the midbrain with a tiny strip of gauze which has been saturated with an irritant. In the course of time a circle of adhesions forms between the margins of the incisura tentorii and the midbrain.

The technic of this procedure is as follows:

A subtemporal bony defect is made on each side and extending posteriorly to the tentorium (osseum in the dog) and inferiorly to the base of the skull. The temporal and occipital lobes are elevated on one side with a spatula until the carotid artery and third nerve are brought clearly into view. With a little additional elevation these structures are put on a stretch and the inferior surface of the midbrain can be seen. The third nerve is the most important landmark. The end of the gauze strand is passed under the mesencephalon to a point on the opposite side of the brain and emerges contralaterally just behind the third nerve. The operator then shifts to the opposite side of the table and elevates the other side of the brain until the third nerve is exposed on this side. The end of gauze will then be seen protruding and can easily be grasped with forceps. By gentle traction half of the strip of gauze is pulled under the midbrain, so that an equal length of gauze is on either side. The brain is then allowed to settle. The next step consists in retracting the occipital lobes forward, first on one side and then on the other, until the margins of the incisura tentorii can be distinctly seen. The gauze strip

is then carefully inserted between the midbrain and the margins of this dural opening. The gauze is then in close apposition to the entire circumference of the midbrain and also of the dural edge (Fig. 11).

It has been found by experience that it is necessary to saturate the gauze with iodin in order to produce adhesions. Gauze not so treated becomes incorporated as a smooth foreign body, without adhesions, and has no effect upon the continuity of the subarachnoid space, and consequently there is no effect upon the distribution of cerebrospinal fluid. It is entirely probable that the irritant alone will produce the same result. In areas over the surface of the occipital lobe, which were unavoidably touched with the iodin, firm adhesions bound the tentorium to the brain. There has been no mortality incident to this operation.

Following the application of the perimesencephalic band, hydrocephalus develops almost as rapidly as following occlusion of the aqueduct of Sylvius (Fig. 12). That the subarachnoid space around the midbrain is obliterated by adhesions can be graphically demonstrated, by substituting India-ink for cerebrospinal fluid in the cisterna magna two hours before the animal is sacrificed. The ink granules are distributed through every part of the subarachnoid space which is open to the cerebrospinal fluid. By fixing the brain with intravascular formalin the ink granules are deposited, making a striking and permanent record. Normally, ink so introduced into the subarachnoid space will cover the whole brain in this period of time and a small amount may even pass through the foramina of Luschka into the fourth ventricle. When hydrocephalus results from a perimesencephalic barrier of adhesions, the ink cannot pass beyond this obstruction (Figs. 13 and 14). On the other hand, in the specimen of hydrocephalus which has resulted from the perimesencephalic band, all the dilated ventricles are full of ink because the foramina of Luschka (the foramen of Magendie is absent in the dog) are enlarged, permitting an easy backward passage of cerebrospinal fluid into all the cerebral ventricles. Although valves are not present, normally the approximation of the cerebellum to the

FIG. 12.—Section of a dog's brain in which hydrocephalus has followed the application of the band around the midbrain, as described in Fig. 11. The figure on the right is a section of a normal dog's brain at the same level. The hydrocephalus is of three months' duration. These sections are taken from the brains shown in Figs. 13 and 14. Compare the ventricular dilatation with that in Fig. 10 in which the vein of Galen was ligated. (Drawing by Mr. Brödel.)

FIG. 13.—Drawings by Mr. Brödel, showing the result of injections of India ink into the spinal canal two hours before the animals were sacrificed. On the right the entire brain is colored black, as occurs normally. On the left the ink stops at the perimesencephalic band and can get no farther. In other words, the black area represents the amount of subarachnoid space reached by the cerebrospinal fluid—*A*, in the animal in which a band is around the midbrain, and *B*, the normal. Hydrocephalus of the "communicating" type results because most of the absorbing area of subarachnoid space has been eliminated by this extraventricular obstruction.

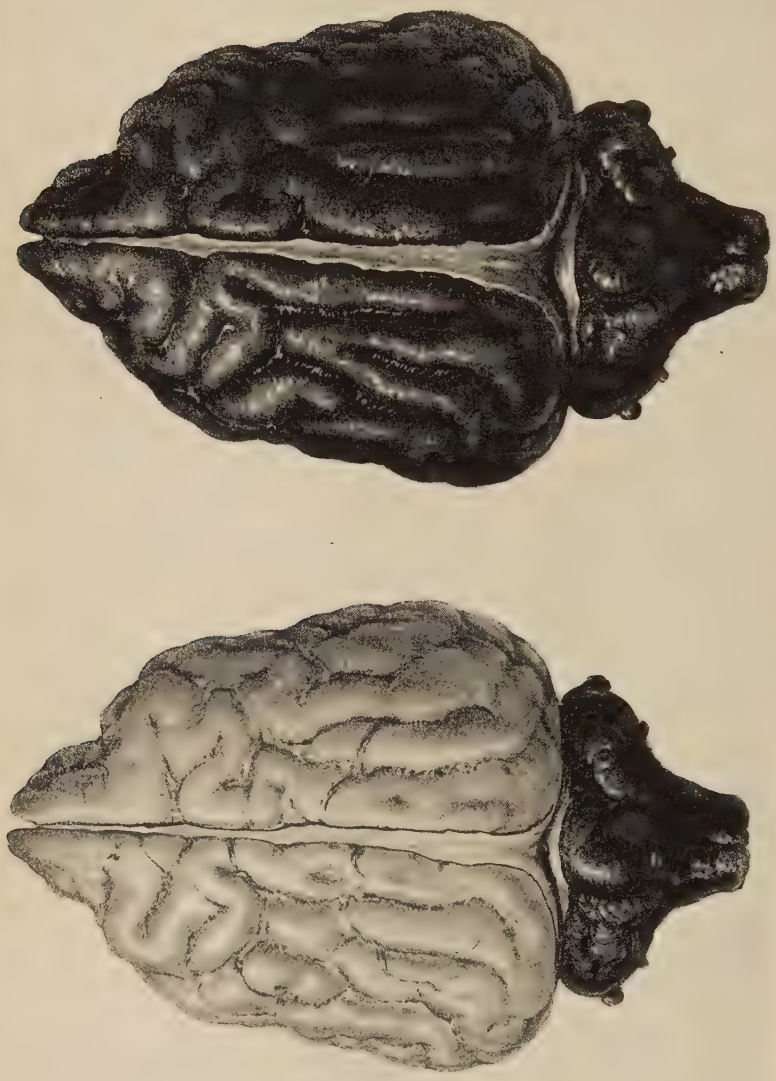


FIG. 14.—Drawings by Mr. Brödel of dorsal view of same brains as Figs. 12 and 13. It will be seen that the black ink stops at the tentorium cerebelli; it covers the cerebellum completely but none of the subarachnoid space over either cerebral hemisphere is reached. Section of these brains is shown in Fig. 12. Mr. Brödel has shown the light and dark surfaces of the brain in transverse sections also (Fig. 12). The ink filled the ventricles in the hydrocephalic brain but did not reach them in the normal brain (Fig. 13).

medulla prevents more than a trace of the colored fluid, which is in the spinal canal, reaching the ventricles. In experimental communicating hydrocephalus the presence of such a large amount of ink in the ventricles, together with a sharp color-line at the obstruction, is positive proof that there was ample opportunity for ink to reach the cerebral subarachnoid space if it were possible. This barrier of adhesions was therefore the sole cause of the hydrocephalus, which can be explained by assuming a reduction in the amount of the area for the absorption of cerebrospinal fluid. The dilatation of the aqueduct of Sylvius and presence of ink in the lateral ventricles also demonstrate that the circle of adhesions around the midbrain did not in any way constrict the aqueduct of Sylvius and thereby cause the hydrocephalus. The band of adhesions need not hermetically seal the subarachnoid space to produce hydrocephalus, for in one case a slight channel permitted a little fluid (ink) to trickle through for a short distance. It is entirely possible that if adhesions are not too dense such tiny channels may eventually dilate and modify the rate of development of the hydrocephalus or even overcome the effects of obstruction, and reaching the cisternæ beyond, reëstablish the continuity between the cerebellar and cerebral subarachnoid spaces. Spontaneous cures of hydrocephalus not infrequently occur, and such a development could readily afford an explanation.

Summary and Conclusions. 1. Hydrocephalus has been produced by placing an obstruction in the aqueduct of Sylvius. Dilatation of the third and both lateral ventricles results.

2. One foramen of Monro has been occluded; this is followed by a unilateral hydrocephalus.

3. If the choroid plexus of one lateral ventricle is completely removed at the time the foramen of Monro is occluded, not only does no dilatation occur, but the entire lateral ventricle collapses.

4. This is the only absolute proof that the cerebrospinal fluid is formed from the choroid plexus. At the same time it proves that the ependyma does not secrete cerebrospinal fluid.

5. If the choroid plexus of both lateral ventricles is removed,

and an obstruction is placed in the aqueduct of Sylvius, hydrocephalus still results in the third and both lateral ventricles, but at a reduced rate. The fluid forms from the choroid plexus of the third ventricle but cannot escape into the subarachnoid space.

6. Cerebrospinal fluid forms in all the cerebral ventricles. It is absorbed almost entirely in the subarachnoid space. The sole communication between the ventricular system and the subarachnoid space is through the foramina of Luschka and the median foramen of Magendie.

7. The phenolsulphonephthalein test will prove conclusively whether the foramina of Luschka and Magendie are open or closed. Closure of these foramina invariably causes hydrocephalus.

8. Hydrocephalus follows ligation of the vena magna Galeni if the ligature is placed at the origin of this vein. Ligatures beyond or in the sinus rectus have no effect because there is sufficient venous collateral circulation.

9. The communicating type of hydrocephalus has been produced in dogs by a perimesencephalic band of gauze, saturated in an irritant which induces adhesions. This obstruction prevents cerebrospinal fluid from reaching the cerebral subarachnoid space where most of the cerebrospinal fluid is absorbed. The resultant diminished absorption of fluid results in hydrocephalus.

10. Hydrocephalus follows ligation of the great vein of Galen because of an overproduction of cerebrospinal fluid. In other types of hydrocephalus, both obstructive and communicating, the accumulation of fluid is due to a diminished absorption of cerebrospinal fluid.

AN ANALYSIS OF THE RESULTS OF SIX YEARS' FOLLOW-UP SYSTEM IN A SURGICAL SERVICE

By C. L. GIBSON, M.D.
NEW YORK

This paper is a study of the end-results obtained on the First Surgical Division of the New York Hospital from February 1, 1913, to January 1, 1919. This period covers 8028 patients, 7175 operations and 385 deaths. Sixty of these deaths were in non-operative cases. The cases have been followed according to the outline given in my paper, "A Surgical Follow-up System," in the *Annals of Surgery*, September, 1916.

Briefly, the great bulk of cases, exception only being made for minor infections, etc., are examined three months after operation by the surgeon in whose charge the patient was or who performed the operation. Patients not reporting are written to. The excellent Social Service Department of the Hospital has been able to trace numerous cases and give us some information about their condition. Cases of particular interest are followed for longer periods; for instance, the direct herniæ are followed for nine months, malignant tumors indefinitely. Patients are directed at the time they leave the hospital and also when they return for examination to come back to see the attending surgeon if at any time they develop symptoms or complaints. They are particularly encouraged to come on Mondays at three o'clock, which is our Field Round

Day, and the entire staff is present. The condition of the patients is indicated as follows:

Excellent means that the patient returns, presenting absolutely no symptoms of any kind whatsoever and expresses himself in perfect health and perfectly satisfied with his surgical condition.

Satisfactory means there are no direct symptoms referable to his surgical condition, but that the patient may have some complaint, be that as it may, *e. g.*, constipation.

Unsatisfactory means that the patient has not been improved or that there is a definite failure to obtain the desired results.

We have reason to believe that the tabulated results are made to appear bad by the fact that a large number of patients remaining in good health and having no complaints do not respond to requests for information or examination. A very large proportion of these patients are recent and ignorant immigrants who exhibit little gratitude for benefits received, certainly not enough to give up half a day's work to report. *Per contra*, if anything is the matter with them they are very anxious to confront the doctor with the fact.

The work has been done for the most part by myself and the two associate surgeons, Dr. B. J. Lee and Dr. J. M. Hitzrot. In the first part of 1913 it was our privilege to have the coöperation of Dr. W. A. Downes, who was then associate surgeon. Dr. C. E. Farr, assistant surgeon, also has taken part in some of the work, and particularly during the period of the War.

Two periods of these six years have given unsatisfactory results. The system began in 1914, but for the sake of completeness, we went back and investigated, so far as we were able, our 1913[1] work but were unable to trace a considerable portion of these cases. From July, 1917, to the end of this period war conditions materially handicapped us.

The responsibility of keeping track of these patients and sending for them has been entirely in the hands of Mrs. H. S.

[1] The division has been conducted by the Cornell Medical College since 1913.

Harrison, and it is largely owing to her coöperation and the fact that this responsible part of the work has been done by one person that we have been able to get data of value.

Space will not allow of very detailed comments on these cases. Some of the more important groups will be the basis of papers to be published by the staff.

Whatever merit this publication may contain is believed to be due to the complete report of the entire service for six consecutive years, as studies of this kind are rare.

The educational value of the information obtained by a study of end-results has been particularly impressed on the whole staff as time has gone on. It was not long before several surprising factors became apparent and we were able to substitute definite data for vague impressions. In several instances it came as a shock that we were getting poor or bad results of which we were in blissful ignorance and were stimulated to improve our work with beneficial results. We have a weekly conference of the whole staff, which includes a report of the follow-up work of the previous week, and, in addition, quarterly and annual reports, so that all members of the staff are constantly in touch with the situation.

In view of our enforced revision of judgment concerning our end-results obtained by the follow-up system, we feel a certain reluctance to accept statements on such matters unless there is evidence that a systematic effort is made to check up such results.

The First Surgical Division of the New York Hospital is under the control of Cornell Medical College, and for eight months of the year there is very active teaching.

So far as feasible some of the major groups of cases are assigned to particular members of the staff. For purposes of convenience a certain uniformity of technic obtains, but the staff is not limited to any one method of treatment. This policy gives the individual operator opportunities to develop his own ideas and furnishes a comparison of different methods.

In the past year we have replaced disinfection of the skin by

tincture of iodine by 5 per cent. picric acid alcohol solution, and are much better satisfied with the results. The asepsis obtained is fully as good, probably better, and the occasional irritation, such as is produced by iodine, has become a thing of the past.

Two and a half years ago it was believed that better results would be obtained by discarding the newer methods of anesthesia, and in that period of time, with very rare exceptions, general anesthesia has been obtained entirely by drop ether on the open cone. It is interesting to note that this method (suppressing preliminary nitrous oxide) does not result in any increased use of ether for the average anesthesia. As time goes on we shall investigate whether the suppression of nitrous oxide has had any relation to the incidence of pulmonary embolism. It is my impression that pulmonary embolism became more marked about the time that complicated methods of anesthesia, particularly those involving the use of nitrous oxide, were introduced.

Anesthesia for five years has been in charge of Dr. W. L. Soule, and this centralization, in the hands of an expert, has been attended with the best results. We have had no case in which death could be attributed directly or indirectly to the anesthetic.

I would make a plea for general anesthesia *versus* the routine use of local anesthesia, which is employed by a great many surgeons, if given in a safe and controllable manner, namely, ether, open cone—by a responsible expert. While local anesthesia undoubtedly has a definite place in a certain group of cases, it is believed it has, on the whole, little or no effect in diminishing mortality.

A certain number of deaths from pulmonary embolism, infarct and thrombosis have been accepted by the surgical profession as seemingly inevitable. Many theories have been advanced to explain their occurrence, but none seems to furnish the true explanation. In all reports one thing stands out prominently, that is, that this condition follows operations

below the diaphragm. In a previous paper[1] I have called attention also to the average age of the patients—namely a large proportion occurring in middle or late life. My observations also rather combated the late development of these conditions. The cases here reported were also all below the diaphragm, but showed an average age of about thirty-two years, an average development of symptoms five days after operation, death about five days later. (Exception is made of a case which died sixty-seven days after operation.)

Our results may be considered from the standpoint of mortality and the restoration of function or return to health of patients. Results will fall into three main groups—namely *Good* (Group I), that is, as satisfactory as at present it is possible to expect; *Average* results (Group II), that is, no better or no worse than what we may commonly expect; and sufficiently *Bad* (Group III), to cause us disquiet and to seek for improvement of results.

Leaving aside the smaller groups for important subjects we have under Group I as follows:

Group I

Malformations.[2] These give good results, particularly in undescended testicle. The deaths were from extreme causes, such as spina bifida.

Circulatory System. Forty-four operations for varicose veins[3] with only two unsatisfactory results.

Digestive System. *Acute Appendicitis* (782 operations, 34 deaths (4.3 per cent.) can, I think, be classified as good, in view of the class of cases admitted). A very large proportion are long-delayed cases, as our unfortunate patients are of a class that do not seek early advice and do not always receive

[1] Pulmonary Embolism following Operation, Medical Record, January 9, 1909.

[2] The Bellevue Nomenclature is employed in all tabulations.

[3] This group will be the subject of a special paper.

prompt attention, necessitating, necessarily, severer operations and greater risks. We are under the impression today that, if anything, the delay in sending in cases is increasing. Only 5 cases of this group are noted as coming back with conditions marked unsatisfactory, in marked contrast with the large number of cases of chronic appendicitis presenting subsequent complaints.

SUMMARY OF DEATHS FROM ACUTE APPENDICITIS

Number of deaths, 36.
Number of operations, 34.
Males, 18; Females, 18.

Ages.		Time elapsing between onset of attack and operation.	
1 to 10 years,	5	1 day,	3
10 to 15 "	6	2 days,	12
15 to 20 "	3	3 days,	3
20 to 30 "	8	4 days,	3
40 to 50 "	6	5 days,	5
50 to 60 "	6	6 days,	2
60 to 70 "	2	8 days,	1
		2 weeks,	2

One case too ill to obtain a history. Another ill four weeks. No definite history of acute attack.

All cases save one required drainage. All were complicated by peritonitis. Further complications were:

Pneumonia, 2.

Intestinal obstruction, 4; paralytic ileus, 1.

Pneumococcus infection, 1.

Suppurative pleurisy, necessitating second operation, 2.

Pulmonary infarct, 3.

Acute cholecystitis, 1.

Secondary exploration of subphrenic space for multiple abscess of liver, 1.

Acute cardiac dilatation, 1.

Nephritis, 2.

Tonsils (559 operations with 1 death). This death was in no way connected with the operation, but the patient died eleven days after operation of meningitis. The operation performed was usually some form of radical enucleation and the functional results were exceedingly good.

Hemorrhoids (184 operations, no deaths). Only 3 unsatisfactory results. This result was an agreeable surprise to us, for without this definite tabulation we would not have realized how uniformly successful this operation was.

HERNIÆ. *Femoral Hernia* (53 operations, 1 death). No recurrence. Unsatisfactory cases are those showing same pain as before operation, but no recurrence.

Femoral Hernia, Strangulated (11 operations, 1 death) gave uniformly good after-results.

Inguinal Hernia (of 849 operations, 168 were for bilateral hernia; total number of operations, therefore, 933). Of the 65 cases of bilateral hernia operated on before 1916, 61 were operated on at one sitting, 2 at two sittings. From 1916–1919 of 103 bilateral herniæ, 96 were operated on at one sitting, 7 at two sittings. Of these 103 cases 15 were direct, 68 indirect, 20 both direct and indirect. Since 1916 there have been 305 cases of hernia on the right side (including bilateral hernia). Of this number 142 have had their appendix removed.

There were two deaths, in one case from pulmonary embolism after a long illness. In this case the appendix had been removed with great difficulty. The second was an elderly man, a poor risk, who died from cardiac insufficiency and paralytic ileus. So far as mortality is concerned, we believe our results are good, as owing to the greater demands for operation today the average age is much higher than it was some years ago. For some years we had made a practice of removing the appendix on the right side in a rather haphazard fashion, but today we make it a routine, providing the conditions allow of a perfectly safe and easy removal, as we believe no risks should be taken of unduly traumatizing the intestine. It is interesting to note that three

patients in whom the appendix was sought for and the search abandoned for the above reasons subsequently returned to us for an operation for acute appendicitis. Possibly in cases in which we cannot easily draw down the appendix and cecum there may be a chronic appendicitis which calls for operation. It has been interesting to note with what frequency the appendices removed as routine have shown pathological lesions, concretions, etc. In one case the appendix was full of pus.

As regards recurrences, we have definite knowledge of only twenty, but believe that it must be higher. We believe that the direct herniæ are more prone to recur and require special technic. We believe that we present here a higher percentage of operations for direct herniæ than is commonly reported, and attribute the fact to our methods of demonstrating the presence of direct hernial sacs which are often overlooked, unless care is taken in searching for them. In fact, we have come to regard this careful extirpation of the entire direct sac as the most important feature in obtaining a radical cure in addition to the special technic of replacing the deficient conjoined tendon, either by transplantation of the rectus, or, in addition, suturing the cut edge of the rectus sheath to Poupart's ligament.

Infective Diseases. *Tetanus* (3 cases, all recovered). All treated by intraspinal injections of antitoxin in addition to other treatment.[1]

Tuberculosis of Kidney (15 operations without mortality). One subsequently died at home, in 2 the end-results are not known. In the others the improvement in health and the disappearance of symptoms were, for the most part, very marked and gratifying.

Reproductive Organs (Female). *Extra-uterine Gestation* (51 operations, 2 deaths). Many of these are ambulance cases, desperately ill. It is therefore fair to consider the mortality, 4 per cent., very good.

[1] See article Comparative Value of the Methods of Treating Tetanus, in the American Journal of the Medical Sciences, December, 1916.

Chronic Salpingitis (211 operations, 5 deaths, represent in many cases very severe conditions, long-neglected cases and huge suppurating tubes). Our experience has taught us that so-called conservative measures, *i. e.*, saving a doubtful second tube or partial resection of a tube, are unsatisfactory; in fact, they generally leave the patient in a bad condition and more usually necessitate a second operation. Bilateral cases are best treated by a panhysterectomy, for, as a general rule, leaving a boggy incurably diseased uterus is poor surgery.

Reproductive Organs (Male). *Hydrocele* (62 operations; *varicocele*, 78 operations, gave surprisingly good results). The operation usually employed for varicocele was the high excision of veins; for hydrocele, radical excision, chiefly by von Bergmann's method.

Tumors (Benign). *Fibromyoma of uterus* gives a small mortality and very satisfactory after-results.

Fibroadenoma of Breast. These operations, if done properly, with the Thomas special submammary incision, give excellent results, especially from the cosmetic standpoint. In only two of these patients are recurrences noted, and probably from insufficient excision. I should like to call attention to the fact that in the twenty-five years of my hospital surgery I have performed a goodly number of operations for benign conditions of the breast, which I believe have acted as a prophylaxis against carcinoma. I have never yet had one of these patients return to me with carcinoma of the breast or have I ever heard of such a condition developing in any of my patients.

Urinary Organs. *Nephrolithiasis and Calculus in Ureter* (52 cases, 30 operations, 2 deaths, which were exaggerated conditions, requiring a nephrectomy in the presence of a marked pyonephrosis). It will be noted that operations for displaced kidney (nephroptosis) were very infrequent, as we believe they should be.

Abscess of Kidney and Perinephritic Abscess (28 operations, 2 deaths). Results excellent, only 2 cases being reported unsatisfactory.

DUCTLESS GLANDS AND SPLEEN. *Diseases of the Spleen,*[1] *Including Echinococcus Cyst* (12 cases, 10 operations, 1 death). The fatal case was one of splenomyelogenous leukemia, in which nothing further than an exploration was possible.

Of the splenectomies, 1 Banti's disease, 1 syphilitic enlargement, 1 von Jaksch's anemia, 1 hemolytic jaundice, 1 pernicious anemia, and 1 echinococcus cyst have remained well, all with marked improvement.

One Banti's disease, 1 portal cirrhosis with splenomegaly (non-alcoholic) and 1 pernicious anemia died after short improvement.

INJURIES. *Fractures* (*Including Faulty Union*). During the period of these statistics 447 fractures were treated. There were 24 deaths (14 in the skull fractures); 236 cases reported for observation, of these 53 were excellent, 163 satisfactory and 21 unsatisfactory; 47 cases were not asked to return, because the treatment received at the hospital could have no bearing on the result.

There were 168 operations done, with 12 deaths; 10 in fractures of the skull, 2 in fractures of the femur (shock 1, pulmonary embolism, 1).

The operative measures used with autogenous bone grafts, 30 cases (4 failures with subsequent operations in 2 cases); heterogeneous bone graft (beef bone) in 6 cases, with 1 failure; Lane plate 28 cases, with 1 infection and 2 removals; Freeman external bone clamp, 2 cases; Quenu-Matthieu apparatus, 2 cases; suture of fragments, 33 cases; wiring, 2 cases; metal screw, 1 case; nail extension, 1 case; osteotomy, 9 cases; excision of fragments, 12 cases; arthroplasty for ankylosis following fracture, 6 cases; amputation, 8 cases. The remaining 30 operations were done to correct deformities, which after correction needed no fixation or for coincident soft part injury (skull fractures).

[1] The Effect of Splenectomy on the Normal Individual and in Certain Pathological Conditions, by James Morley Hitzrot, Annals of Surgery, May, 1918.

Group II

Digestive System. *Cholelithiasis and Cholecystitis* (214 cases, 179 operations, 12 deaths). Many of these cases presented the terminal stages of severe infections and numerous cases of obstructive jaundice. It is not surprising, therefore, that the mortality should be a little high. The results, on the whole, were pretty fair, but we feel that we must exert considerable efforts to improve them. As regards cholecystotomy *versus* cholecystectomy, as time goes on the latter operation has been more frequently performed, so that it is today the routine operation that we perform with improvement of results. A few cases have been encountered with carcinoma of the gall-bladder developing after a cholecystotomy some time before. A cholecystectomy done at the primary operation would probably have eliminated the possibility of the carcinoma developing.

There has been no attempt to make use of the transverse incision for gall-bladder approach, as we have found in cases of common duct obstruction that the vertical incision, close to the middle line, is ample and usually gives very satisfactory exposure.

Pancreatitis. Of the 6 cases surviving operation all reported as in a satisfactory condition of health. The three deaths were very severe cases, two dying within a few hours after an exploratory operation.

Ductless Glands and Spleen. *Exophthalmic Goitre.* There were two deaths following ligation of a single artery under local anesthesia. Both were severe cases which had grown steadily worse under prolonged medical treatment. The surviving cases showed, on the whole, fairly good results, certainly about as good as one can ever expect to get following operation.

Herniæ. *Inguinal Hernia, Strangulated* (41 operations, 6 deaths). Of these 6 deaths, 3 cases required intestinal resection, 2 were complicated by pneumonia and 1 case was a poor operative risk, a man seventy years of age. The ages of these cases were thirty-eight years, thirty-nine years, fifty-four years,

sixty years, seventy years and seventy-two years. The two youngest patients died of pneumonia. This is a class, especially in elderly individuals, where a two-stage operation has given in many cases good results. The first operation, done under local anesthesia, is limited to overcoming the obstruction, usually very easy, or remedying the damage to the gut by an appropriate resection. The second stage for the repair of the hernia is done a few days later, usually under a general anesthetic, when the patient has recovered from the shock and disturbance of his original condition.

Umbilical and Ventral Herniæ. Both radical cure and operation for strangulation, 87 cases, 74 operations, 12 deaths. Seemingly this mortality is too high, but it must be remembered that a large proportion of these people are quite unsuitable for operation, many of them being stout, elderly women with degeneration of the viscera and changes in the bloodvessels. Operation for radical cure was seldom done except in the face of a threatening condition or the patients refusing to suffer the discomfort of a permanently irreducible hernia. In the strangulated conditions the operation is always prolonged and difficult and often requires intestinal resection.

INFECTIVE DISEASES. *Tuberculosis of the Digestive System.* Peritoneum (18 original cases, 3 deaths).

Report on 9 cases:

One case died two weeks after leaving hospital.

Date of operation.	Date of last report.
June, 1918	May, 1919. Gained 13 pounds. No symptoms.
Apr. 9, 1917	May 22, 1917. Recurrence of condition. Sent to country.
June 5, 1918	Oct. 10, 1918. Feels much better. Gained 3 to 5 pounds. Still has abdominal sinus and free discharge.
July 19, 1917	Nov. 4, 1918. Fat and well. Complains of pain in right lower quadrant and vague symptoms.
Nov. 22, 1914	Mar. 15, 1915. Working and well.
Aug. 6, 1915	Nov. 29, 1915. Patient has gone to Germany. In good health.
Aug. 25, 1915	Feb. 13, 1919. Marked improvement. Abdomen soft, no fluid. No masses felt. Gained in weight.
Oct. 1915 No operation.	Jan. 1916. Looks very badly.

Cases found under those returning for second operation:

5 cases. 1 death in hospital. 1 case twenty-one days after leaving hospital.

1 case not found. Report of other 2:

Operation, September 24, 1917. Note December 31, 1917. General Condition markedly improved. Still has an open granulating wound discharging some pus.

Operation for tuberculosis of kidney, October 4, 1915. Operation for tuberculosis of peritoneum, January, 1917. January 5, 1919, absolutely all right.

Reproductive Organs. *Acute Salpingitis.* On the whole, we do not favor operations in the acute stages, as convalescence is rather stormier and the risk somewhat greater. Operation has more often been resorted to when the patients failed, under observation, to show speedy signs of improvement. A certain number of cases have wisely been operated on at this stage, owing to the real difficulty sometimes encountered in differentiating between acute right salpingitis and appendicitis, and we prefer to take no chances when such a doubt exists.

Prolapse, Retroflexion, Retroversion, Lacerated Cervix and *Relaxed Pelvic Floor.* While the results, on the whole, are satisfactory, we are seeking constantly to improve our methods, especially in the very extreme cases of prolapse of the third degree. It is not our custom to operate on retroversion, simply on the anatomical finding, but to relieve definite symptoms. The repair of laceration of the cervix gave good results.

Group III

Digestive System. *Ulcer of Stomach and Duodenum.* The results in this class of cases were unsatisfactory as regards operative mortality, 8.5 per cent., which is rather high, although the more recent work has shown marked improvement in that direction. They are, of course, unselected cases and many of them present advanced conditions, making operative proced-

ures complicated and difficult. As regards functional results, on the whole, they are fair. The best results have been obtained in the well-defined, duodenal ulcers, treated by gastro-enterostomy without any other operative procedure. A few cases had some form of blocking of the pylorus added to the gastro-enterostomy. On the whole, these cases did not do so well and this procedure has been abandoned by me. More recently we have had the benefits of better and more accurate ante-operative observation and diagnosis, such as fluoroscopic examination (by Dr. A. L. Holland), with resulting benefits to our results in every way.

Ulcer of Stomach and Duodenum, Perforating. The results are twofold; the operative mortality, which is too high (10 deaths out of 39 operations), but the after-results have been very good, no case being recorded as unsatisfactory and the great bulk of patients have shown marked improvement in health. Gastro-enterostomy at the time of the original operation has only very exceptionally been performed. None of the cases here recorded has undergone it subsequently. The mortality of the perforating ulcer of the stomach is almost entirely a question of time and the following table simply serves to demonstrate this fact. It will be noted that only one case died who was operated on less than twenty-four hours after the perforation occurred.

Time Elapsing between Perforation and Operation. (Report on 39 cases of perforating ulcer of stomach and duodenum.)

1. Deaths (10).

48 hours (2).
46 hours.
36 hours.
24 hours (3).
12 hours.

Note: One patient ill ten days. Another too ill to obtain detailed history. Patient had apparently been ill two weeks.

2. Still living (29).
   - $1\frac{3}{4}$ hours.
   - Between 2 and 3 hours (2).
   - Between 3 and 4 hours (5).
   - 4 hours (2).
   - 5 hours (6).
   - 7 hours.
   - 8 hours (3).
   - $9\frac{3}{4}$ hours.
   - 17 hours.
   - 24 hours (4).
   - 3 days.
   - 5 days.
   - 10 days.

The last patient was operated on five days after admission for abdominal abscess; five days later for perforating ulcer. His illness had been of two weeks' duration. Operation for ulcer ten days after admission.

Cirrhosis of Liver (5 operations, 3 deaths). In general our impression has been that the results from omentopexy for cirrhosis of the liver are usually bad. Most of the cases are exceedingly poor operative risks, with marked renal disease, who react very unfavorably to operative procedures. We believe that only a very favorable case should be considered for operation.

Chronic Appendicitis (552 operations with 3 deaths). As the number of unsatisfactory cases is quite large a very exhaustive investigation of the subject will be published by me soon. The number of unsatisfactory cases, 30 per cent., is somewhat exaggerated, as we have definite reasons for believing that in the 139 non-investigated cases we probably had the best results. We may say, in general, that the results were best in the male, in patients with definite history of previous attacks, in cases presenting well-marked pain over the site of the appendix as the principal symptoms. Also, in patients whose general intelligence and knowledge of the English language allowed them

to give satisfactory histories. In the thoroughly satisfactory cases the appendix is definitely noted as obviously pathological in 86 per cent., while the proportion diminishes as the results become unsatisfactory. Of recent years all operations have been conducted as exploratory laparotomies—that is, the small "interval" incisions have been abandoned. Of our 246 excellent cases only 6 were readmitted while 100 unsatisfactory yielded 26 readmissions.

Infective Diseases. *Typhoid Fever, with Perforation.* All cases died, although it is fair to believe that in at least 2 cases the patients died of the typhoid fever and not of the sequelæ of the perforation or operation. The operation is, for the most part, done under local anesthesia, with the help of generous doses of morphin. Typhoid fever is not coming to operation any earlier nowadays, because much time is lost in making blood examinations, which in the presence of the customary leukopenia are a waste of time.

Lymphadenitis, Tuberculous. This is one of the most unsatisfactory problems. The class of cases chosen is usually those in whom operation could not be avoided; that is, with established or threatened suppuration. Twenty-two of these patients required subsequent operations for the removal of recurrent nodes, and it will be noted that no case was described as excellent. It must, however, be admitted that the classification is a little too severe, as a failure to record a case as excellent is often based on the presence of palpable lymph nodes in the neck, which are practically always present in the neighborhood of the operative field. So far as feasible, other remedial measures were effected—removal of diseased tonsils, care of the teeth, and sojourn in the country—but, of course, in only a limited number.

Reproductive Organs (Male). *Hypertrophy of the Prostate.* The mortality is higher in these ward cases (4 deaths after removal of the prostate, 1 death after drainage under local anesthesia) and does not represent the true status of prostatic surgery. Here again we have the neglected terminal stages in

which we are forced to resort to some form of intervention. Our experience in private work, with well-selected cases, is much more satisfactory. The removal in all cases was by the suprapubic method to which we are now committed. However, the results of these operations were, on the whole, quite good.

TUMORS (MALIGNANT). This is the saddest part of our study. The tables speak for themselves and require little comment. However, fortunately, this study does not quite fairly represent the cancer situation, as this entire paper is based on the admissions to the wards, who are chiefly neglected, hopeless cases. Results in private work are better, but not sufficiently so to make us optimistic. Moreover, the cancer situation has been complicated by the introduction of various therapeutic measures, some holding out some legitimate hope for their usefulness, others of the fake or "catch-penny" sort. These result in confusion to the profession and deception to the public, and the pitiful cancer sufferer is made the victim, as he does not get a square deal.

An attempt has been made to analyze the opinions that cancer patients receive prior to their admission to the hospital. These have been collected by Dr. Farr in a paper entitled "Delay in the Treatment of Cancer."[1]

It will be noted that none of these cases is recorded as excellent. We do not feel that we can so classify them, owing to the possibility of a recurrence. We have therefore divided them into two groups: satisfactory (free from recurrence) and unsatisfactory (recurrences).

Carcinoma of the Breast. In general, our follow-up report of breast carcinoma shows that recurrence is much more frequent than one would believe from the literature. We believe that a patient should be in good condition six years after operation to count a case as cured. As our series only goes back six years we believe that not enough time has elapsed for us to draw definite conclusions. In our study of breast cases we believe that cases come too late for operation and that progress must be made toward earlier recognition and earlier operation.

[1] American Journal of the Medical Sciences, January, 1919.

SUMMARY OF CARCINOMA CASES (INCLUDING CARCINOMA, ADENOCARCINOMA AND EPITHELIOMA)

Number of cases, 259
Number of known deaths, 169
Number of cases living, 41 (10 of these were unsatisfactory)
Unknown, 49
Number of operative cases (202):

A. Number of deaths		130	
1. In hospital	47		
2. At home	83		
B. Satisfactory results		29	
C. Unsatisfactory results		8	
D. Unknown		35	
1. Of this number 20 were followed in part (12 satisfactory, 8 unsatisfactory)			
E. No specimen removed, 15		—	202
Number of cases not operated upon (57):			
A. Number of deaths		39	
1. In hospital	5		
2. At home	34		
B. Satisfactory (dubious diagnosis)		2	
C. Unsatisfactory		2	
D. Unknown		14	
1. Of this number 2 cases were followed in part, both being unsatisfactory.		—	57
			259

REPORT OF CARCINOMA CASES THAT ARE STILL LIVING

Diagnosis.	Date of operation.	Date of last report.	Satisfactory condition.	Unsatisfactory (recurrence).
		1913		
Breast	Nov., 1913	Dec. 1918	Yes	
		1914		
Breast	Mar., 1914	July, 1918	Yes	
Breast	Aug., 1914	Sept., 1918	....	Yes
Stomach	Mar., 1914	Mar., 1919	Yes	
Stomach	July, 1914 (operation refused)	Jan., 1919	Yes	
Face	Jan., 1914	Jan., 1919	Yes	
Lip	May, 1914	Apr., 1919	Yes	
Tongue	Sept., 1914	Feb., 1919	Yes	

Diagnosis.	Date of operation.	Date of last report.	Satisfactory condition.	Unsatisfactory (recurrence).
		1915		
Appendix	Feb., 1915	Mar., 1919	Yes	
Breast	July, 1915	Apr., 1919	Yes	
Breast	Mar., 1915	Mar., 1919	Yes	
Stomach[1]	Nov., 1915	Feb., 1919	Yes	
Face	Nov., 1915	Jan., 1919	Yes	
		1916		
Breast	Jan., 1916	Dec., 1918	Yes	
Breast	Mar., 1916	Jan., 1919	Yes	
Breast	Aug., 1916	Feb., 1919	Yes	
Stomach[1]	Nov., 1916	Sept., 1918	Yes	
Uterus	Jan., 1916	Feb., 1919	....	Yes
Uterus	Apr., 1916	Apr., 1919	....	Yes
Lip	Mar., 1916	Apr., 1919	Yes	
		1917		
Breast	Feb., 1917	Feb., 1919	....	Yes
Breast	Apr., 1917	Jan., 1919	Yes	
Breast	June, 1917	Mar. 1919	....	Yes
Breast	Feb., 1917	Feb., 1919	Yes	
Breast	June, 1917	Mar., 1919	....	Yes
Lymph nodes	June, 1917	Oct., 1918	Yes	
Rectum	June, 1917	Mar., 1919	Yes	
Intestines	Oct., 1917 (operation refused)	Apr., 1919	Yes	
Uterus	Aug., 1917	May, 1919	Yes	
		1918		
Bladder	Oct., 1918	Mar., 1919	Yes	
Bladder	Mar., 1918	Apr., 1919	Yes	
Breast	Oct., 1918	Mar., 1919	Yes	
Breast	Aug., 1918	Apr., 1919	....	Yes
Breast	May, 1918	Mar., 1919	Yes	
Larynx	Feb., 1918	Apr., 1919	Yes	
Lymph nodes	Aug., 1918	Jan., 1919	Yes	
Intestines	Oct., 1918 (operation refused)	Feb., 1919	....	Yes
Uterus	Dec., 1918	Apr., 1919	....	Yes
Uterus	Mar., 1918	Feb., 1919	Yes	
Uterus	Mar., 1918	Nov., 1918	Yes	
Lip	Feb., 1918	Apr., 1919	....	Yes

[1] Diagnosis probably wrong—no specimen.

REPORT ON "UNKNOWN RESULTS"

Number of unknown cases, 49. Of this number 14 had no operation.

Cases having no note, 27. Cases followed in part, 22.

Diagnosis.	Date of operation.	Date of last note.
		1913
Breast	Sept., 1913	June, 1914. Satisfactory.
Breast	Mar., 1913 (no operation)	No note.
Intestines	Nov., 1913	July, 1916. Satisfactory.
Maxilla	Apr., 1913	No note.
Fallopian tubes	June, 1913	No note.
Stomach	Feb., 1913 (no operation)	No note.
Uterus	July, 1913 (no operation)	No note.
Omentum	Mar., 1913	No note.
		1914
Breast	June, 1914	Mar., 1917. Satisfactory.
Breast	May, 1914	No note.
Intestines	May, 1914	Oct., 1914. Losing strength rapidly. In bed all the time.
Intestines	Apr., 1914	Aug., 1914. Slightly improved.
Lymph nodes	Nov., 1914	Dec., 1915. Slightly improved.
Uterus	Aug., 1914 (no operation)	No note.
Uterus	Aug., 1914	No note.
Ovary	Feb., 1914	No note.
Lip	Dec., 1914	No note.
Lip	Feb., 1914	No note.
Lip	Jan., 1914	July, 1916. Satisfactory.
Penis	Jan., 1914	Jan., 1915. Satisfactory.
		1915
Breast	Oct., 1915	Feb., 1916. Satisfactory.
Bladder	Aug., 1915	Dec., 1915. Unimproved.
Intestines	Sept., 1915	No note.
Prostate	Apr., 1915	No note.
Stomach	May, 1915	No note.
Stomach	May, 1915	June, 1915. Feels better. Has returned to work.
Stomach	May, 1915	No note.
Uterus	Oct., 1915	Jan., 1916. Living on coal barge.
Lip	Aug., 1915	Feb., 1916. Satisfactory.

Diagnosis.	Date of operation.	Date of last note.	
		1916	
Breast	Aug., 1916 (no operation)	Apr., 1918.	Losing ground rapidly.
Esophagus	July, 1916	July, 1917.	Unimproved.
Rectum	Nov., 1916 (no operation)	No note.	
Stomach	Dec., 1916	Jan., 1917.	Return of symptoms.
Face	Jan., 1916	Dec., 1916.	Satisfactory.
Vulva	June, 1916	Nov., 1916.	Marked recurrence.
		1917	
Breast	June, 1917	Nov., 1917.	Satisfactory.
Breast	June, 1917	Apr., 1918.	Extensive recurrence.
Intestines	Mar., 1917	No note.	
Intestines	Aug., 1917 (no operation)	No note.	
Prostate	Dec., 1917 (no operation)	No note.	
Rectum	Jan., 1917 (no operation)	No note.	
		1918	
Breast	Mar., 1918	No note.	
Intestines	Aug., 1918 (no operation)	No note.	
Intestines	July, 1918 (no operation)	No note.	
Prostate	Oct., 1918 (no operation)	No note.	
Stomach	Mar., 1918	No note.	
Thyroid	Aug., 1918 (no operation)	Nov., 1918.	Very ill.
Ovary	Aug., 1918	Nov., 1918.	Satisfactory.
Tongue	Mar., 1918 (no operation)	No note.	

The accompanying tables give the details of the results obtained:

REPORT OF FOLLOW-UP WORK FROM FEBRUARY, 1913, TO DECEMBER, 1918, INCLUSIVE

Diagnosis.	No. of cases.	No. of deaths.	No. of operations.	Readmitted.	Second operation.	To return.	Reported.	Excellent.	Satisfactory.	Unsatisfactory.	Died at home.
CONGENITAL ABNORMALITIES AND MALFORMATIONS											
Malformations	87	(1)15	73	Tonsils	1	57	45	24	17	4	
				Neurasthenia	0						
				Hare-lip	Died						
BLOOD											
Streptococcus blood infection	1	0	0	.....	0						
BONES AND CARTILAGES											
Abscess of bone	2	0	2	.....	...	2	0				
Faulty union	22	0	22	Faulty union (4 cases)	2	19	17	2	13	2	
				Fracture of femur	Died						
Necrosis	3	0	3	Abscess	1	2	2	..	2		
Osteomyelitis	104	9	93	Osteomyelitis (11 cases)	8	69	50	10	29	9	2
Ostitis deformans	1	0	1	.....	...	1	1	..	1		
Periostitis	5	0	2	.....	...	3	2	..	1	..	1
BURSÆ											
Bursitis	26	0	20	Bursitis	1	19	14	8	5	1	
				Ulcer, leg	1						
CIRCULATORY SYSTEM											
Aneurysm	8	1	8	Aneurysm	1	6	3	..	2	1	
Arteriosclerosis	1	0	1	.....	...	1	1	..	1		
Cardiac valvular disease	2	0	0	.....	...	0					
Endarteritis obliterans	8	0	5	Endarteritis	3	8	6	1	3	1	1
Myocarditis	1	0	0	.....	...	0					
Thrombosis	1	1	1	.....	...						
Varicose veins	49	0	44	Varicose veins	1	42	32	12	18	2	
DIGESTIVE SYSTEM											
Appendicitis, acute	789	36	782	Fecal fistula	3	623	502	313	182	5	2
		(2)	..	Ventral hernia (11 cases)	10						
				Salpingitis	3						
				Tonsils (3 cases)	2						
				Abdominal sinus	1						
				Cystitis (1)	0						
				Post-operative adhesions (2)	0						
				Cholelithiasis	0						
				Constipation	0						
				Abscess of omentum	1						
				Adenoma of thyroid	1						
				Abscess of leg	1						
				Actinomycosis of colon (1)	Died						
				Foreign body in abdominal sinus	1						
				Pelvic abscess	1						
				Inguinal hernia	1						
Appendicitis, chronic	586	3	552	Cystitis (1)	0	553	414	246	67	100	1
				Post-operative adhesions (7 cases)	5						
				Anteflexion of uterus	1						
				Tonsils	1						
				Hemorrhoids	2						
				Malformation of spinal column	1						
				Chronic myositis (1)	0						
				Post-operative wound	1						
				Constipation (2)	0						
				Hysteria (1)	0						
				Gastroptosis	2						
				Lacerated pelvic floor	1						
				Fissure of anus	1						
				Cholecystitis	1						
				Contusion of breast	0						
				Gastric ulcer (2)	0						
				Furunculosis	0						
				Foreign body in abdominal wall	1						
				Ventral hernia	1						
				Inguinal hernia	1						

REPORT OF FOLLOW-UP WORK—*continued*

Diagnosis.	No. of cases.	No. of deaths.	No. of operations.	Readmitted.	Second operation.	To return.	Reported.	Excellent.	Satisfactory.	Unsatisfactory.	Died at home.
				Circumcision	1						
				Cystoma of ovary	1						
				Pyonephrosis	1						
				Tuberculous intestine	Died						
Colitis	7	2	2	Stricture of urethra	1	3	3	..	1	2	
Constipation	48	0	6	Chronic appendix	2	4	4	..	2	2	
Diverticulitis	2	0	2	.....	...	1	1	..	..	..	1
Fecal fistula	2	0	2	Abdominal sinus	1	2	0				
				Ventral hernia	1						
Dilatation of cecum	1	0	1	.....	...	1	1	..	1		
Gastro-enteritis	5	0	0	.....	...	0					
Mesenteric thrombosis	6	(1) 6	6								
Intestinal obstruction	38	(2) 17	36	Ventral hernia	1	17	14	7	5	2	
Intestinal hemorrhage	1	0	1	.....	...	1	1	1			
Visceroptosis	14	0	2	.....	...	2	2	..	2		
Ulcer of cecum	1	0	1	.....	...	1	1	1			
Stricture of intestine	1	1	1	.....							
Abscess of liver	6	0	6	Abscess-liver	1	4	3	2	..	1	
Cirrhosis of liver	7	3	5	.....	...	4	4	..	1	..	3
Cholelithiasis and Cholecystitis	214	14	179	Abscess of muscle	1	166	142	48	80	12	2
	..	(2)	..	Stenosis of gall-bladder	Died						
				Post-operative adhesions	4						
				Constipation	0						
				Ventral hernia	2						
				Carcinoma of gall-bladder	Died						
				Fibromyoma of uterus	1						
				Tuberculous vertebra	0						
				Cholelithiasis	Died						
				Strangulatedinguinalhernia	1						
Pelvic abscess	6	(1) 2	4	.....	...	3	2	..	1	1	
Adhesions of peritoneum	36	1	25	Ventral hernia	1	24	23	3	13	7	
Peritonitis	18	(2) 10	16	.....	...	7	5	2	2	1	
Tonsils and adenoids	561	1	559	Circumcision	1	281	227	173	53	..	1
				Pulmonary tuberculosis	0						
				Tuberculosis of hip	1						
Abscess of pharynx	3	1	2	.....	...	2	1	1			
Foreign body in esophagus	3	0	2	.....	...	2	2	1	..	..	1
Stricture of esophagus	1	0	0	.....	...	1	1	..	1		
Ulcer of mouth	2	0	2	.....	...	2	2	..	2		
Alveolar abscess	13	0	11	.....	...	2	2	..	2		
Pancreatitis	9	3	9	.....	...	6	6	4	2		
Abscess about the rectum and fistula in ano	98	..	97	Axilla abscess	1	61	46	14	26	6	
				Abscess of rectum	2						
				Stricture of urethra	1						
				Fistula in ano	7						
				Inguinal hernia	1						
				Hemorrhoids	1						
				Lacerated tendons	1						
				Stricture of rectum	1						
Fissure of anus	4	0	4	.....	...	4	3	3			
Hemorrhoids	191	0	184	Duodenal ulcer	Died	114	73	25	45	3	
				Gastric ulcer	1						
				Teratoma	1						
				Fistula	1						
				Pyelitis	0						
Prolapse of rectum	3	0	3	Prolapse of rectum	0	2	2	..	1	1	
Proctitis	1	0	1	.....	...	0					
Stricture of rectum	4	0	2	.....	...	3	2	..	2		
Ulcer of rectum	2	0	1	.....	...	1	1	1			
Acute dilatation of stomach	1	0	1	.....	...	1	1	..	1		
Gastritis	4	0	0	.....	...	0					
Foreign body in stomach	1	0	0	.....	...	0					
Hypochlorhydria	2	0	0	.....	...	0					
Pyloric spasm	2	0	2	.....	...	2	1	..	..	1	
Stenosis of pylorus	1	1	1	.....							
Ulcer of:	93	7	70	Perforated ulcer	Died	62	55	28	22	4	1
Stomach	..	(1)	..	Ulcer, stomach	0						
Duodenum	..	..	..	(2)							
				Carcinoma of stomach	Died						

REPORT OF FOLLOW-UP WORK—*continued*

Diagnosis.	No. of cases.	No. of deaths.	No. of operations.	Readmitted.	Second operation.	To return.	Reported.	Excellent.	Satisfactory.	Unsatisfactory.	Died at home.
				Revision of gastro-enterostomy	1						
				Salpingitis	1						
				Adhesions	1						
				Neurasthenia	0						
Ulcer of stomach, perforating	40	11(1)	39	.....	...	29	26	10	16		
Ductless Glands and Spleen											
Exophthalmic goitre	12	2	9	Goitre	1	8	5	1	3	1	
Simple cystic goitre	12	0	9	.....	...	8	4	2	2		
Suppurative thyroiditis	1	0	1	.....	...	1	1	..	1		
Diseases of spleen	11	1	9	Banti's disease (1)	Died	6	6	4	1	..	1
				Splenomegaly	Died						
Ear											
Otitis media and mastoiditis	16	0	8	.....	...	13	8	4	4		
Eye											
Ulcer of cornea	1	0	0	.....	...	1	0				
Herniæ											
Epigastric	4	0	4	Ventral	1	4	3	..	2	1	
Femoral	54	1	53	Inguinal hernia	2	46	40	27	10	3	
				Relaxed pelvic floor	1						
				Prolapse of uterus	1						
Femoral:											
Strangulated	11	1	11	.....	...	9	9	5	4		
Inguinal	872	2	849	Hernia, opposite side	10	780	539	319	209	11	
				Recurrence	9						
				Cellulitis of wound (2)	1						
				Tonsils	2						
				Hydrocele	2						
				Endothelioma of submaxillary nodes	0						
				Varicose veins	1						
				Carcinoma of bladder	1						
				Hemorrhoids	2						
				Acute appendicitis	3						
				Congenital malformation of testicle	0						
				Tuberculosis of vertebra	1						
				Inguinal abscess	1						
				Femoral hernia	1						
Inguinal: strangulated	41	6	41	Tuberculosis of peritoneum	2	34	25	16	7	1	1
				Strangulated hernia of opposite side	1						
Umbilical	22	2	21	.....	0	17	14	4	9	1	
Umbilical strangulated	9	5	9	Fibroid uterus	0	4	3	..	2	..	1
	..	(1)	..	Inguinal hernia	1						
Ventral	49	2	39	Salpingitis	2	33	26	17	8	1	
				Tuberculosis of vertebra	0						
				Hemorrhoids	1						
Ventral strangulated	7	3	5	Intestinal obstruction	Died	2	1	..	1		
		(1)									
Infective Diseases											
Abscess	115	4	110	Abscess	4	73	52	20	25	5	2
				Chronic appendix	1						
				Tuberculosis of vertebra	0						
				Tuberculosis of peritoneum	Died						
Carbuncle	21	2	21	.....	...	8	7	3	4		
Cellulitis	100	5	90	Post-operative hemorrhage	1	71	53	13	34	6	
				Contracture	1						
				Abscess	1						
Erysipelas	2	0	0	.....	0						
Furunculosis	5	0	5	.....	...	3	3	1	2		
Glanders	1	1	1								
Gonococcus infection	3	0	2	.....	...	1	1	..	1		
Jaundice	1	0	0	.....	...	0					
Rheumatic fever	3	0	0	.....	...	2	2	..	2		

REPORT OF FOLLOW-UP WORK—*continued*

Diagnosis.	No. of cases.	No. of deaths.	No. of operations.	Readmitted.	Second operation.	To return.	Reported.	Excellent.	Satisfactory.	Unsatisfactory	Died at home.
Syphilis	29	0	13	Syphilis	0	20	10	2	7	..	1
Tetanus	3	0	2	Osteomyelitis	1	3	3	1	2		
Tuberculosis of bones	41	0	36	Pulmonary tuberculosis	0	31	25	1	17	7	
				Tuberculosis of costal cartilage	1						
				Tuberculosis of bones	1						
				Tuberculosis of skin	1						
				Chronic endometritis	1						
Bursa	2	0	2	.....	...	1	1	..	1		
Digestive system	24	5	18	Same	0	14	10	..	7	2	1
Joints	46	1	37	Same (8)	7	31	25	1	12	10	2
Muscular system	7	(1) 1	7	.....	...	5	5	..	4	1	
Epididymis	10	0	6	Same	2	6	4	..	3	1	
Fallopian tubes	8	0	8	Same	1	8	6	..	5	1	
	..	..	..	Tuberculosis of vertebra	1						
Pulmonary tuberculosis	18	(1) 1	2	.....	...	4	4	..	2	..	2
Skin	4	0	2	.....	...	3	3	2	1		
Urinary organs (bladder, 1; kidney, 25)	26	0	15	Tuberculosis of peritoneum	1	21	18	6	6	3	3
				Tuberculosis of properitoneal tissue	1						
				Tuberculosis of kidney	1						
				Tuberculosis of bone	1						
Acute general tuberculosis	1	(1) 1	0								
Typhoid fever	2	0	1	.....	...	1	1	..	1		
Typhoid fever with perforation	6	6	6								
JOINTS											
Ankylosis	14	0	11	Same	3	9	7	..	5	2	
Arthritis	34	0	24	Same	2	19	12	2	6	4	
				Cellulitis	1						
Coxa vara	1	0	0	.....	...	1	1	..	..	1	
Genu valgum	8	0	7	.....	...	6	4	..	3	..	1
Genu varum	12	0	6	.....	...	4	4	..	3	1	
Hallux valgus	8	0	8	.....	...	8	6	3	2	1	
Pes planus	6	0	0	.....	...	5	3	1	2		
Pes cavus	1	0	1	.....	...	0					
Talipes	3	0	3	Talipes	1	3	3	1	2		
LYMPHATIC SYSTEM											
Lymphadenitis (simple)	49	0	40	Salpingitis	1	22	14	4	9	1	
Lymphadenitis (tuberculous)	104	0	100	Tuberculosis of lymph nodes	22	83	66	..	48	16	2
				General tuberculosis	0						
				Tonsils	3						
				Osteomyelitis	1						
Elephantiasis	2	1	2	.....	...	1	1	..	..	1	
Hodgkin's disease	4	0	3	.....	...	3	3	..	2	1	
MISCELLANEOUS											
Miscellaneous diseases	57	2	34	.....	...	22	18	4	10	3	1
MUSCLES AND TENDONS											
Diseases of muscles and tendons	20	0	16	.....	...	14	12	9	3		
NERVOUS SYSTEM											
Diseases of nervous system	31	4	8	.....	...	5	5	..	2	3	
REPRODUCTIVE ORGANS (FEMALE)											
Dysmenorrhea	3	0	1	Appendicitis, acute	1	2	2	2			
Metrorrhagia	4	0	2	Metrorrhagia	1	3	3	..	2	..	1
				Chorio-epithelioma of uterus	1						
				Endometritis	1						
Sterility	1	0	0	.....	...	0					
Galactocele	1	0	1	.....	...	1	0				
Hypertrophy of breast	1	0	1	.....	...	0					
Mastitis	44	0	40	Same	4	36	26	19	5	1	1
Pelvic cellulitis	3	1	3	Cystoma, ovary	1	2	2	1	1		
Extra-uterine gestation	52	(1) 3	51	Endometritis	1	45	33	18	11	4	
				Cystoma, ovary	1						
				Phlebitis	0						
				Intestinal colic	0						

REPORT OF FOLLOW-UP WORK—*continued*

Diagnosis.	No. of cases.	No. of deaths.	No. of operations.	Readmitted.	Second operation.	To return.	Reported.	Excellent.	Satisfactory.	Unsatisfactory.	Died at home.
Hematosalpinx	1	0	1	.....	...	1	1	1			
Oöphoritis	9	0	8	.....	...	7	6	3	2	1	
Salpingitis, acute	47	(1) 3	43	Acute gastritis	0	37	27	14	11	2	
				Tuberculosis of peritoneum	1						
				Cystoma, ovary	1						
				Ventral hernia	1						
Salpingitis, chronic	244	5	211	Rectovaginal fistula	0	165	118	39	67	11	1
				Pyelitis	0						
				Post-operative adhesions	1						
				Ganglion	1						
				Ventral hernia (2)	1						
				Intestinal obstruction	Died						
				Ventral hernia	Died						
				Pelvic peritonitis	0						
				Pelvic abscess	1						
				Endotrachelitis	0						
				Appendicitis, chronic	1						
				Cystoma, ovary	0						
				Relaxed pelvic floor	0						
				Fibromyoma	1						
				Salpingitis (2)	0						
				Abortion induced	1						
Displacement of uterus:											
Anteflexion	14	0	13	.....	...	10	8	2	5	1	
Anteversion	2	0	2	Anteversion	1	2	1	..	1		
Prolapse	26	1	21	Abscess of vulva	1	19	15	4	8	3	
				Prolapse	0						
				Cystocele	1						
Retroflexion	6	0	6	.....	...	4	3	2	..	1	
Retroversion	64	0	61	Salpingitis	1	46	33	8	20	5	
				Endometritis	1						
				Induced abortion	1						
Endometritis	127	0	118	Cystoma of ovary	1	83	48	14	22	12	
				Salpingitis (5)	3						
				Varicose veins	1						
				Extra-uterine	1						
Endotrachelitis	3	0	2	Tuberculosis of appendix	1	2	2	..	..	2	
Lacerated cervix	20	0	15	Abscess about rectum	1	12	11	2	7	2	
Stricture of uterine canal	5	0	4	.....	...	4	3	..	2	1	
Abscess of Bartholin's gland	10	0	9	.....	...	5	4	3	1		
Abscess of vulva	2	0	2	.....	...	1	0				
Atresia of vagina	1	0	1	.....	...	1	0				
Rectovaginal fistula	2	0	1	.....	...	1	0				
Ureterovaginal fistula	1	0	1	.....	...	1	1	1			
Relaxed pelvic floor	121	2	109	Endotrachelitis	1	92	75	30	37	8	
				Fibroid uterus	3						
				Hematoma	1						
				Endometritis	1						
				Pleurisy	0						
				Cystoma	1						
				Pyelitis	0						
				Salpingitis	1						
				Ureteral colic	0						
				Abscess, rectum	1						
Vaginitis	2	0	0	.....	...	0					
REPRODUCTIVE ORGANS (MALE)											
Phimosis and redundant prepuce	73	0	68	Tonsils	1	25	20	18	2		
				Adenitis	0						
Abscess of prostate	5	0	4	.....	...	2	2	1	..	1	
Hypertrophy of prostate	22	5	19	Hydrocele	1	14	10	3	5	1	1
				Stricture of urethra	1						
				Inguinal hernia	1						
Abscess of scrotum	2	0	1	.....	...	0					
Calculus of prostate	1	0	0	.....	...	1	0				
Prostatitis	1	0	0	.....	...	1	0				
Acute orchitis	1	0	0	.....	...	0					
Hydrocele	65	0	62	Hydrocele	2	45	31	20	10	1	
				Abscess of scrotum	1						
				Tuberculosis of nodes	1						

REPORT OF FOLLOW-UP WORK—*continued*

Diagnosis.	No. of cases.	No. of deaths.	No. of operations.	Readmitted.	Second operation.	To return.	Reported.	Excellent.	Satisfactory.	Unsatisfactory.	Died at home.
Varicocele	79	0	78	Cellulitis of scrotum	1	60	36	18	17	1	
Spermatocele	2	0	2	.....	...	1	1	..	1		
Epididymitis	9	0	4	Epididymitis	...	3	3	2	1		
PARASITES											
Entamebic dysentery	1	0	1	.....	...	1	1	1			
Echinococcus cysts	1	1	1								
RESPIRATORY SYSTEM											
Abscess of lung	4	1	4	Inguinal hernia	1	3	2	1	1		
Suppurative pleurisy	96	14(1)	89	Suppurative pleurisy (7)	5	49	45	26	17	1	1
				Abscess of lung (2)	Died (1)						
				Bronchiectasis	1						
Lobar pneumonia	2	2 (1)	1								
NASAL PASSAGES AND ACCESSORY SINUSES											
Sinusitis	3	0	3	.....	...	3	2	1	1		
SKIN, HAIR AND NAILS											
Cicatrix of skin	3	0	3	.....	...	3	2	..	1	1	
Callosities	1	0	1	.....	...	0					
Eczema	1	0	0	.....	...	0					
Ingrowing nail	4	0	3	.....	...	3	3	1	1	1	
Pruritus of scrotum	1	0	0	.....	...	1	1	..	1		
Ulcer	4	0	4	.....	...	4	4	4			
TUMORS (BENIGN)											
Angioma	8	0	7	.....	...	5	3	1	2		
Adenoma	6	0	6	.....	...	6	4	3	1		
Cystoma of ovary	67	3	64	Fistula in ano	1	56	42	12	25	5	
(5 exceptions: thigh, vaginal wall, ulna, jaw and sacral region)	..	..	..	Cholelithiasis	1						
				Arthritis	0						
				Syphilis	1						
				Calculus ureter	1						
				Endometritis	1						
				Fibromyoma	1						
				Salpingitis	1						
				Abscess	1						
				Cystoma	1						
Chondroma	2	0	2	.....	...	2	1	1			
Fibroma of:											
Arm	1	0	1	.....	...	1	1	..	1		
Abdominal wall	1	0	1	.....	...	1	1	1			
Alveolar ridge	1	0	1	.....	...	1					
About anus	1	0	1	.....	...	0					
Neck	3	0	3	.....	...	3	2	1	1		
Skin (keloid)	2	0	2	.....	...	2	2	..	..	2	
Lipoma	19	0	19	Lipoma	2	15	10	7	2	1	
Lymphangioma	1	0	1	.....	...	1	1	..	..	1	
Osteoma	8	0	6	Revision of stump	1	6	5	1	3	1	
				Osteoma	1						
Papilloma	11	1	11	Papilloma	0	10	10	5	5		
				Umbilical hernia	1						
Neuroma	1	0	1	.....	...	1	1	..	1		
Polyp	7	0	7	Salpingitis	1	2	1	..	1		
Retention cyst	15	0	15	Fistula in ano	1	5	3	2	1		
				Otitis media	0						
Teratoma	9	0	9	.....	...	8	3	1	1	..	1
Fibro-adenoma of breast	18	0	17	.....	...	16	14	12	0	2	
Fibro-angioma	2	0	2	.....	...	2	2	1	1		
Fibromyoma of uterus	145	4	133	Carcinoma of uterus	1	108	81	34	38	4	5
				Cholecystitis	1						
				Vulvovaginal abscess	1						
				Adhesions	2						
				Lacerated pelvic floor	1						
				Constipation	0						

REPORT OF FOLLOW-UP WORK—*continued*

Diagnosis.	No. of cases.	No. of deaths.	No. of operations.	Readmitted.	Second operation.	To return.	Reported.	Excellent.	Satisfactory.	Unsatisfactory.	Died at home.
Fibrolipoma	1	0	1	.....	...	1	1	1			
Lympho-angiofibrolipoma	1	0	1	.....	...	1	1	1			
Osteochrondroma	2	0	2	.....	...	2	2	1	1		
Unknown	3	0	0	.....	...	0					
TUMORS (MALIGNANT)											
Carcinoma of:											
Appendix	2	1	2	.....	...	1	1	..	1		
Bartholin's gland	1	0	1	.....	...	1	1	..	..	..	1
Bladder	10	2	7	.....	...	8	7	..	2	..	5
Breast	51	0	48	Recurrence	Died	50	41	..	12	4	25
Gall-bladder	6	2	5	.....	...	4	4	..	..	..	4
Intestines	33	11	25	Recurrence	1	21	14	..	1	1	12
Larynx	1	0	1	.....	...	1	1	..	1		
Liver	6	3	6	.....	...	3	3	..	..	..	3
Lymph nodes	6	0	5	.....	...	6	5	..	2	..	3
Maxilla	3	1	3	.....	...	2	1	..	..	..	1
Esophagus	4	1	4	.....	...	3	2	..	..	..	2
Pancreas	7	(1) 4	3	.....	...	3	3	..	..	..	3
Peritoneum	2	2	2								
Prostate	5	1	2	.....	...	4	1	..	..	..	1
Rectum	11	(1) 3	7	.....	...	8	6	..	1	..	5
Stomach	40	(1) 11	30	Recurrence	Died	28	22	..	4	..	18
Thyroid	2	(1) 1	0	.....	...	1	0				
Fallopian tubes	3	0	3	.....	...	3	2	..	..	..	2
Uterus	32	1	21	Recurrence	3 2 died	29	25	..	3	3	19
Ovaries	5	2	5	.....	...	3	1	..	..	..	1
Endothelioma of:											
Nodes of neck	3	0	3	.....	...	3	1	..	..	1	
Ovary	1	0	1	.....	...	1	1	..	1		
Parotid	1	0	1	.....	...	1	1	..	1		
Arm	1	0	1	.....	...	1	1	..	..	..	1
Epithelioma of:											
Face	3	0	3	.....	...	3	2	..	2		
Lip	8	0	8	.....	...	8	4	..	2	1	1
Penis	1	0	1	.....	...	1	0				
Tongue	14	(1) 1	8	Recurrence Excision of nodes	1 2	13	12	..	1	..	11
Vulva	1	0	0	.....	...	0					
Hypernephroma (kidney)	1	(1) 1	0								
Sarcoma of:											
Abdominal wall	1	0	1	.....	...	1	1	..	..	..	1
Bones	7	0	7	Recurrence	1 1 died	6	6	..	2	1	3
Breast	1	0	1	Recurrence	Died						
Leg	1	0	1	.....	...	1	0				
Intestines	1	1	1		...						
Gum	1	0	1	.....	...	1	1	..	1		
Kidney	1	0	1	Recurrence	Died						
Lymph nodes	4	0	4	.....	...	4	1	..	..	..	1
Rectum	1	0	1	.....	...	1	0				
Spleen	1	1	1								
Tendon sheath	1	0	1	.....	...	1	1	..	1		
Testicle	1	0	1	.....	...	1	1	..	..	..	1
Teratoma, malignant											
Retroperitoneal nodes	1	0	1	.....	...	1	1	..	..	..	1
Adenocarcinoma of omentum	2	0	2	Recurrence	Died	1	0				
Adenopapilloma	1	1	1								
Fibrosarcoma of:											
Finger	1	0	1	.....	...	1	1	..	1		
Ovary	1	0	1	.....	...	1	0				
Lymphosarcoma of:											
Intestines	1	0	1	.....	...	1	0				
Jaw	1	(1) 1	0								
Lymph nodes	2	0	2	.....	...	2	2	..	1	..	1
Myosarcoma of intestines	1	0	1	.....	...	1	1	..	1		
Myxochondro-endothelioma of parotid	2	0	2	.....	...	2	1	..	1		
Submaxillary gland	4	0	4	.....	...	4	1	..	1		

REPORT OF FOLLOW-UP WORK—*continued*

Diagnosis.	No. of cases.	No. of deaths.	No. of operations.	Readmitted.	Second operation.	To return.	Reported.	Excellent.	Satisfactory.	Unsatisfactory.	Died at home
URINARY ORGANS											
Abscess of urethra	1	0	1	Fistula in ano	1	1	0				
Calculus in bladder	6	0	4	Calculus	Died	3	2	..	2		
Cystitis	16	2	3	Pulmonary tuberculosis	0	5	4	..	2	..	2
Calculus in ureter	10	0	4	.....	...	6	6	1	3	2	
Calculus in urethra	2	0	2	Stricture of urethra	1	2	2	..	2		
Caruncle of urethra	1	0	1	.....	...	1	1	1			
Cyst of kidney	2	0	2	.....	...	2	2	1	1		
Hematuria	3	0	3	.....	...	2	1	1			
Hydronephrosis	2	0	2	.....	...	2	2	..	1	..	1
Incontinence	1	0	0	.....	...	0					
Leukoplakia bladder	1	0	0	.....	...	1	0				
Nephralgia	1	0	0	.....	...	0					
Nephritis	10	(4) 5	6	.....	...	4	3	1	1	..	1
Nephrolithiasis	42	2	26	Hematuria	0	28	23	13	9	1	
				Nephrolithiasis	1						
Nephroptosis	10	0	7	Pleurisy	0	7	7	3	2	1	1
Perinephritic abscess	30	(1) 2	28	.....	...	26	19	14	3	2	
Pyelitis	16	0	2	.....	...	9	5	1	4		
Retention of urine	2	1	1	.....	...	0					
Stricture of urethra	31	1	29	Fistula in ano	2	21	10	3	4	2	1
				Acute appendicitis	1						
Stricture of ureter	4	0	4	.....	...	2	2	..	2		
Stricture of neck of bladder	1	0	1	.....	...	1	1	..	1		
Ureteral colic	4	0	0	Abscess prostate	0	4	4	..	3	1	
OBSTETRICAL CONDITIONS											
Abortion, incomplete	102	0	99	Acute cystitis	1	66	44	11	27	5	1
				Salpingitis	2						
				Relaxed pelvic floor	1						
				Fibromyoma	1						
				Incomplete abortion	2						
				Retroversion	1						
				Endometritis	1						
Abortion, threatened	1	0	0	.....	...	0					
Parturition	1	0	1	.....	...	1	1	1			
Pregnancy, normal	24	0	1	.....	...	0					
INJURIES											
Fracture of:											
Ankle	19	0	2	.....	...	16	13	3	8	2	
Clavicle	13	0	0	.....	...	3	2	1	..	1	
Coccyx	1	0	1	.....	...	1	1	1			
Elbow	7	0	4	.....	...	6	4	2	2		
Face, bones of	8	0	4	.....	...	5	5	2	3		
Femur	50	(1) 2	18	Prolapse uterus	1	44	35	9	21	4	1
				Osteomyelitis	2						
				Sinus	1						
				Tonsils	1						
				Foreign body in thigh	1						
				Fractured forearm	0						
				Fractured femur	0						
Foot	12	4	0	.....	...	9	5	2	1	2	
Forearm	48	0	18	Faulty union	2	39	33	5	26	2	
				Fractured forearm	0						
Hand, bones of	13	0	13	.....	...	11	7	1	6		
Humerus	56	0	21	Non-union	1	43	32	9	22	..	1
Leg, bones of	57	0	22	Faulty union	1	42	37	2	32	1	2
				Non-union	1						
				Dermatitis	0						
				Removal plate	1						
Maxilla, inferior:	1	(1) 1	0								
Patella	22	0	19	.....	...	20	13	3	10		
Pelvis	10	0	2	.....	...	6	5	2	2	1	
Ribs	16	(3) 3	0	.....	...	6	3	0	3		
Scapula	9	(1) 1	0	.....	...	7	4	2	1	1	
Skull	43	(8) 14	10	.....	...	16	11	3	8		
Wrist	38	0	6	.....	...	36	25	5	17	3	
Gunshot wound of:											
Radius	1	0	1	.....	...	1	0				
Scapula	1	0	1	.....	...	1	1	..	1		

REPORT OF FOLLOW-UP WORK—*continued*

Diagnosis.	No. of cases.	No. of deaths.	No. of operations.	Readmitted.	Second operation.	To return.	Reported.	Excellent.	Satisfactory.	Unsatisfactory.	Died at home.
Dislocation of:											
Ankle	2	0	1	.....	...	2	2	2			
Cartilage	7	0	6	.....	...	7	7	3	3	1	
Elbow	11	0	4	.....	...	9	7	1	6		
Inferior maxilla	1	0	0	Arthritis	1	1	1	..	1		
Metatarsals	1	0	0	.....	...	1	1	..	1		
Metacarpals	1	0	1	.....	...	1	1	..	1		
Hip	1	0	0	.....	...	1	1	..	1		
Radius	1	0	0	.....	...	1	1	..	1		
Ribs	1	0	1	.....	...	0					
Humerus	20	0	6	Fractured humerus	0	11	7	1	4	2	
				Dislocation	0						
Wrist	5	0	2		...	2	2	1	0	1	
Foreign body in:											
Joint	8	0	8	.....	...	5	5	..	4	1	
Bursa, prepatellar	1	0	1	.....	...	1	1	..	1		
Sprain of sacro-iliac joint	2	0	0	.....	...	1	1	1			
Synovitis, traumatic	3	0	1	.....	...	1	1	..	1		
Contusion of joint	3	0	0	.....	...	0					
Punctured wound of knee	2	0	2	.....	...	1	1	..	1		
Injuries to:											
Digestive system	29	(1) 11	19	Cystoma	1	13	10	4	5	..	1
Ear	2	0	2	.....	...	2	2	2			
Muscular system	37	0	37	Pelvic abscess	1	33	31	2	25	4	
Nervous system	5	1	2	.....	...	0					
Reproductive organs	5	0	2	.....	...	4	3	3			
Respiratory system	4	(1) 1	2	Bronchiectasis	Died	2	2	2			
Spleen	2	0	2	Ventral hernia	1	2	1	1			
Urinary organs	4	1	2	Ventral hernia	1	2	1	1			
Abdominal wall	11	(1) 3	9	.....	...	6	5	3	2		
Back	12	(1) 1	7	.....	...	5	3	3			
Chest wall	4	(1) 1	1	.....	...	2	2	..		1	1
Extremities, lower	42	2	20	Cicatricial contracture	1	24	15	4	10	1	
				Ulcer	0						
Extremities, upper	61	(1) 2	49	Skin-grafting	1	45	37	22	12	3	
				Cellulitis	1						
Face and scalp	25	(1) 1	10	Retroversion	0	10	8	3	4	1	
Neck	4	0	3	.....	...	1	1	1			
Perineum	2	0	1	.....	...	2	2	..	1	1	
Miscellaneous and multiple injuries	20	(5) 7	8	.....	...	7	6	..	5	1	
	8028	358	6808	(Of this number 27 died)	367	5707	4324	1921	1827	393	183
Readmissions	428	27	367								
Total	8456	385	7175								

NOTES.—Total number of known deaths, both in and out of hospital, 568. (Of this number 3 patients died of influenza after leaving the hospital.) Therefore of 8028 cases 7 per cent. are known to be dead.

Of 5707 cases asked to return for examination 75.5 per cent. returned. This percentage is lowered by the inclusion of the two unsatisfactory periods, *i. e.*, the year 1913 and the period of the war. Our percentage under normal conditions has been as follows: Mar. 11, 1916 (three months' report), 93 per cent.; Sept., 1916 (six months' report), 90.6 per cent.; Dec., 1916 (three months' report), 88.7 per cent.; April, 1917 (three months' report), 90.6 per cent.

[1] Under "Number of Deaths," figures in parenthesis denote number included in other figures who died without operation. Of the 358 cases who died in the hospital, therefore, 60 of these had no operation. Operative mortality, 4 per cent.

Appendix

CLASSIFICATION OF PATIENTS RETURNING FOR SECOND OPERATION

MALFORMATIONS

Hare-lip	1 case	1 death
Spinal column	1 case	

BONES AND CARTILAGES

Faulty union	8 cases	
Osteomyelitis	12 cases	
Bursitis	1 case	

THE CIRCULATORY SYSTEM

Aneurysm	1 case	
Endarteritis	3 cases	
Varicose veins	3 cases	

THE DIGESTIVE SYSTEM

Acute appendicitis	3 cases	
Chronic appendicitis	4 cases	
Fecal fistula	3 cases	
Intestinal obstruction	2 cases	2 deaths
Abscess of liver	1 case	
Cholelithiasis	4 cases	1 death
Stenosis of gall-bladder	1 case	1 death
Pelvic abscess	3 cases	
Adhesions of peritoneum (P. O.)	13 cases	
Tonsils and adenoids	11 cases	
Abscess about rectum	4 cases	
Fistula in ano	13 cases	
Fissure of anus	1 case	
Stricture of rectum	1 case	
Hemorrhoids	6 cases	
Gastroptosis	2 cases	
Gastric ulcer	2 cases	
Gastric ulcer, perforating	1 case	1 death
Duodenal ulcer	1 case	1 death

DUCTLESS GLANDS AND SPLEEN

Exophthalmic goitre	1 case	
Banti's disease	1 case	1 death

HERNIÆ

Femoral hernia	1 case	
Inguinal hernia	26 cases	
Inguinal hernia, strangulated	3 cases	
Ventral hernia	22 cases	1 death
Umbilical hernia	1 case	

INFECTIVE DISEASES

Abscess	13 cases	
Cellulitis	4 cases	
Syphilis	1 case	
Tuberculosis of intestines	1 case	1 death
joints	8 cases	
bones	4 cases	
peritoneum	5 cases	1 death
costal cartilage	1 case	
skin	1 case	
epididymis	2 cases	
fallopian tubes	1 case	
properitoneal tissue	1 case	
kidney	1 case	
lymph nodes	23 cases	
appendix	1 case	

JOINTS

Ankylosis	3 cases	
Arthritis	3 cases	
Talipes	1 case	

MISCELLANEOUS

Abdominal sinus	3 cases	
Foreign body in abdominal sinus	1 case	
P. O. wound	1 case	
Foreign body in abdominal wall	1 case	
P. O. hemorrhage	1 case	
Cicatricial contracture	2 cases	
Ganglion	1 case	
Hematoma	1 case	
Revision of amputation stump	1 case	
Foreign body in thigh	1 case	
Skin-grafting	1 case	

PARASITES

Actinomycosis of colon	1 case	1 death

REPRODUCTIVE ORGANS (FEMALE)

Metrorrhagia	1 case	
Mastitis	4 cases	
Extra-uterine gestation	1 case	
Chr. salpingitis	16 cases	
Anteflexion of uterus	1 case	
Retroversion of uterus	1 case	
Prolapse of uterus	2 cases	
Anteversion	1 case	
Relaxed pelvic floor	3 cases	
Lacerated pelvic floor	2 cases	
Endometritis	7 cases	
Endotrachelitis	1 case	
Vulvovaginal abscess	2 cases	

REPRODUCTIVE ORGANS (MALE)

Circumcision	2 cases	
Hydrocele	5 cases	

RESPIRATORY SYSTEM

Suppurative pleurisy	5 cases	
Abscess of lung	1 case	1 death
Bronchiectasis	2 cases	1 death

SKIN, HAIR AND NAILS

Ulcer of leg	1 case	

TUMORS (BENIGN)

Adenoma of thyroid	1 case	
Cystoma of ovary	8 cases	
Fibromyoma of uterus	7 cases	
Teratoma	1 case	
Lipoma	2 cases	
Osteoma	1 case	

TUMORS (MALIGNANT)

Carcinoma of gall-bladder	1 case	1 death
Carcinoma of stomach	2 cases	2 deaths
Carcinoma of bladder	1 case	
Carcinoma of breast	1 case	1 death
Carcinoma of uterus	6 cases	2 deaths
Epithelioma of uterus	1 case	
Epithelioma of tongue	3 cases	
Carcinoma of intestines	1 case	
Sarcoma of bones	2 cases	1 death
Sarcoma of breast	1 case	1 death
Sarcoma of kidney	1 case	1 death
Sarcoma of omentum	1 case	1 death

URINARY ORGANS		
Pyonephrosis	1 case	
Stricture of urethra	4 cases	
Calculus in ureter	1 case	
Calculus in bladder	1 case	1 death
Nephrolithiasis	1 case	
Acute cystitis	1 case	
OBSTETRICAL CONDITIONS		
Incomplete abortion	4 cases	
INJURIES		
Lacerated wound of tendon	1 case	
Fracture of femur	1 case	1 death
	364 cases	26 deaths

THE TRANSPLANTATION OF THE RECTUS MUSCLE OR ITS SHEATH FOR THE CURE OF INGUINAL HERNIA WHEN THE CONJOINED TENDON IS OBLITERATED

AND THE TRANSPLANTATION OF THE SARTORIUS MUSCLE FOR THE CURE OF RECURRENT HERNIA WHEN POUPART'S LIGAMENT HAS BEEN DESTROYED

By JOSEPH COLT BLOODGOOD, M.D.
BALTIMORE

All surgeons admit a small percentage of recurrences after operations for the cure of inguinal hernia even when the wound has healed by first intention.

After my study of the results of the operations performed at Johns Hopkins Hospital up until 1899 I felt convinced that the chief cause of recurrence in the lower angle of the wound was due to the fact that, whether the hernia was direct or indirect—the conjoined tendon was either weak or obliterated, and that the ordinary suture or closure of the defect in the abdominal wall was not sufficiently strong to protect from recurrence in the lower angle.

Reports on the ultimate cure of inguinal hernia previous to those of Halsted and Bassini were complicated by the suppuration of the wound. This factor undoubtedly was the chief cause of recurrence; for this reason lesser factors were not discovered.

Practically all surgeons who have contributed to the operative problem of curing an inguinal hernia recognize the importance of the conjoined tendon. From their description it is clearly

evident that the conjoined tendon was caught in the lower sutures; the internal oblique muscle was sutured to Poupart's ligament; an effort was made to reduce the size of the external ring and make a snug external ring about the cord.

It is quite possible that the failure to cure depended more on the suppuration of the wound than any fault in the suture. McEwen apparently obtained the best results. In every case after his operations the wound was drained. This procedure may have limited infection. The results, however, must have been discouraging, because McBurney in this country left the wound open to heal by granulation. As far as I am able to ascertain, the results of this method were no improvement over the former methods. It is also quite possible that the brilliant results of Halsted and Bassini may have been due to the improvement in wound technic at that time and perhaps to the more perfect asepsis of their respective clinics, and not to the transplantation of the cord.

When I studied the results in Halsted's clinic I also found that when the wounds suppurated, which was not infrequent in the early years of the clinic, recurrence of the hernia was observed in from 25 to 30 per cent. of the cases. However, when the wound healed *per primam*, recurrence was reduced to less than 6 per cent. These recurrences were of two distinct types: One, in the upper angle of the wound, at the position of the transplanted cord, *when the veins were not excised*, usually a small affair, giving very little discomfort and rarely leading to second operation. In the second type the recurrence was in the lower angle of the wound, and my investigations at that time showed that this recurrence had no relation to the position of the cord. It was observed when the cord was and when it was not transplanted or when the cord was excised or castration performed in older patients.

Fortunately, our excellent notes made before and during the operation on the condition of the conjoined tendon allowed me to conclude that the factor which led to the recurrence was the obliteration of the conjoined tendon at the time of the operation.

I have observed both these types of recurrence in patients who have been operated on by the Bassini method, but as my experience with this method is limited entirely to recurrent hernias, I am unable, of course, to obtain any figures as to the exact percentages.

Unfortunately, when Halsted published his first contribution on the cure of inguinal hernia the illustrations and text emphasized the importance of the transplantation of the cord. Nevertheless, in my opinion, this was a minor part of the technic. In one of Halsted's publications he emphasized the importance of closing the defect in the inguinal canal as one would close the wound after any laparotomy—by a most careful suture of all the available fasciæ and muscles without tension with interrupted silk. In Halsted's operation, after the division of the aponeurosis of the external oblique, the division of the covering of the sac, the complete excision of the sac and the closure of the peritoneal cavity high up, the internal oblique muscle was mobilized, so that the conjoined tendon and this muscle could be sutured to Poupart's ligament snugly without tension. During this period surgeons who operated had in mind apparently the transplantation of the cord, and many chose Bassini's method, because it appeared simpler and was less of an operation than Halsted's in which the internal oblique muscle was divided to allow a higher transplantation of the cord. But as far as I can gather, the chief features of Halsted's and Bassini's operation for the cure of inguinal hernia, were the painstaking closure and good healing of the wound.

The objection we found to silk for suture was the increased percentage of suppurations or stitch abscesses. This led Halsted to change to silver wire which was followed by a better percentage of healing. Suppuration of the wound, however, was not practically eliminated until gloves were worn at the operation, then it was found that we could return to the employment of silk as a buried-suture material. Due to the great improvement in the preparation of chromicized catgut I am now using this suture material in place of silk.

Obliteration of Conjoined Tendon. My first publication was in 1898 (*Johns Hopkins Hospital Bulletin*, 1898, ix, No. 86), the second in 1899,[1] and not again until 1918.[2]

During this period I paid much less attention to hernia and operated chiefly on recurrent cases, and my chief interest was centered on that small group of herniæ in which the conjoined

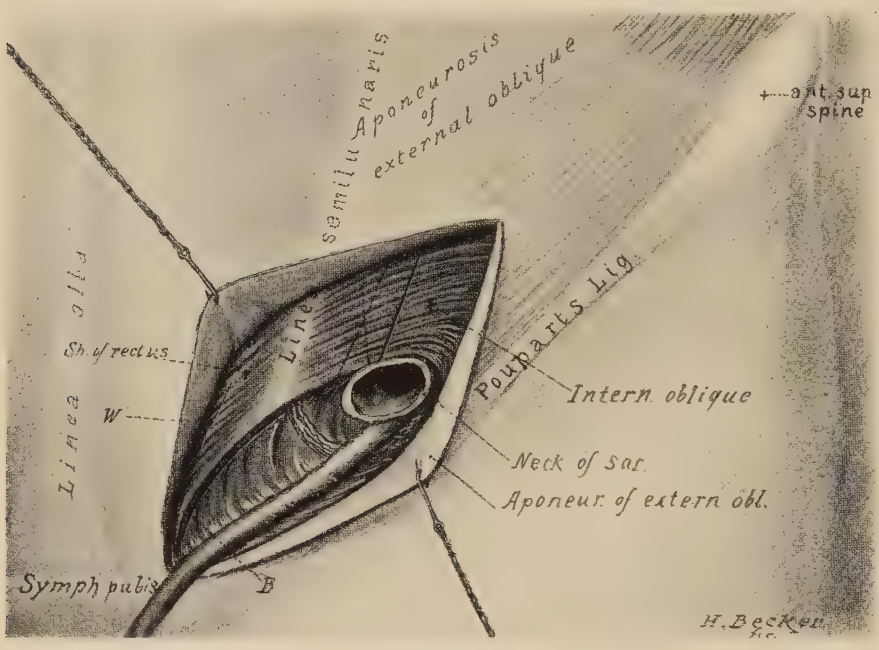


FIG. 1.—Illustrates the anatomy of the inguinal canal.

tendon was obliterated and which I attempted to cure by the transplantation of the rectus or its fascia (Halsted's modification). A careful following of this small group demonstrated that there was a certain percentage of recurrences and that the transplantation of the rectus muscle and its fascia was not a certain cure.

During the recent war I had an opportunity to examine in

[1] Johns Hopkins Hospt. Rep., 1899, vii, 273.
[2] Jour. Am. Med. Assn., February 25, 1918, lxx, 515.

Maryland a large number of selective service men who were placed in Group B because of inguinal hernia. It was very interesting

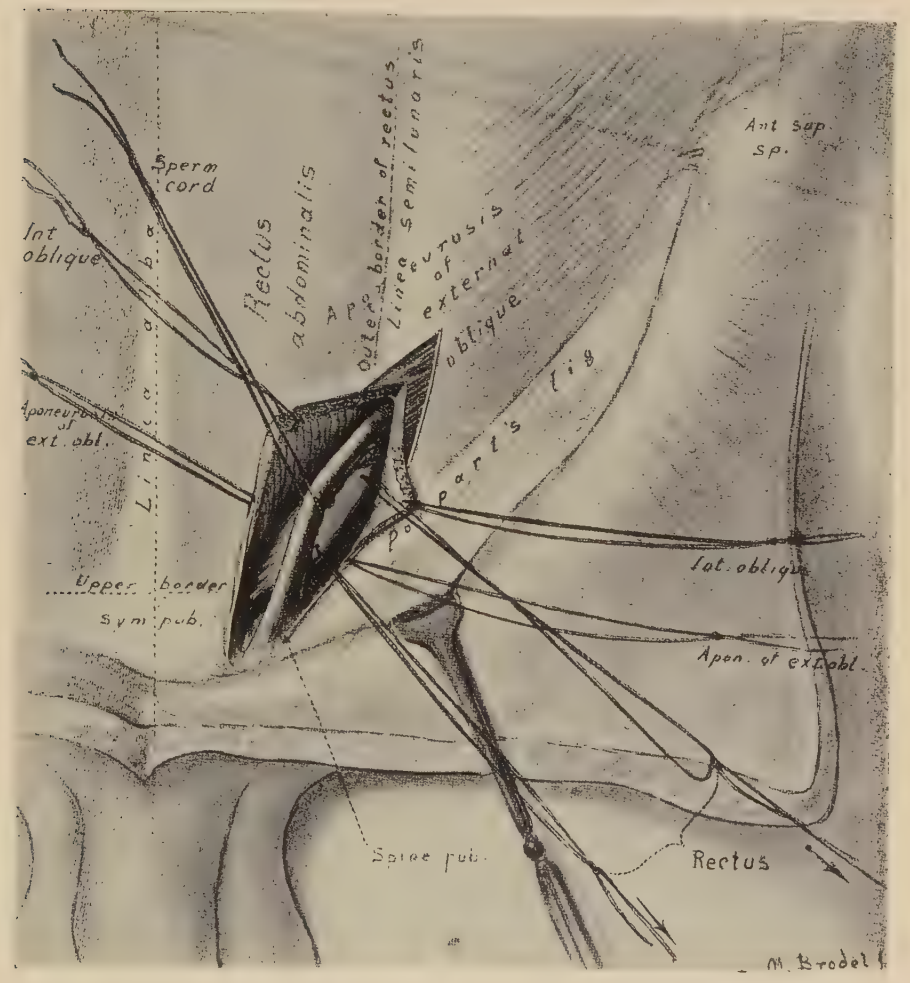


FIG. 2.—My original method of transplanting the rectus with transplantation of the cord—a method from which I got better results than later when the cord was not transplanted.

to me to find that the percentage in which the conjoined tendon was obliterated was about the same as I had found in 1899—

5 per cent. As the majority of these selective service men volunteered to be cured of their defect in order to render service, I had an opportunity in a few months to operate on more than one hundred cases.

As I had had recurrences I felt that some modification must be made to the previous method. In this type of hernia, when one

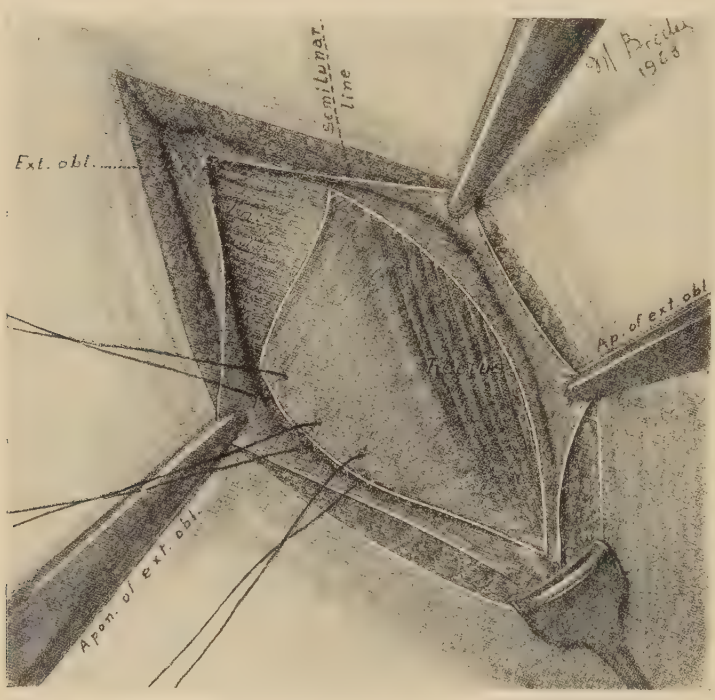


FIG. 3.—Halsted's modification of transplantation of the rectus sheath without transplantation of the cord.

invaginates the scrotum and introduces the finger into the external ring, little or no resistance is met and the finger passes over the pubic bone, and, as a rule, can be pushed into the space of Retzius behind the rectus muscle. When this anatomical defect is present on both sides the two fingers meet behind the recti.

The weakness in the abdominal wall is therefore bounded laterally by Poupart's ligament and the rectus muscle, and below by the pubic bone. The firm and perfect closure of this opening is hampered by the presence of the cord.

When I first transplanted the rectus in order to suture it to Poupart's ligament and thus strengthen the defect in the lower angle of the wound due to the obliteration of the conjoined tendon, I also transplanted the cord and excised the veins as in the Halsted operation (Fig. 2).

Since my publication in 1899 we discontinued to transplant the cord and rarely excised the veins, and when this rarer type of inguinal hernia presented itself, we continued the method of transplantation of the rectus, usually with Halsted's modification of transplanting its sheath (Fig. 3), but we did not transplant the cord.

As far as I am able to ascertain, in the group in which I had transplanted the cord (Fig. 2) there has been only one recurrence, but since the change in technic of leaving the cord undisturbed in the lower angle of the wound I know of at least four recurrences in operations which I performed myself, and it seems strange that this made no impression.

The last operation performed by me of this later technic was May 20, 1918. But shortly after this operation a patient on whom I had operated March 16, 1918, suffered a recurrence. This patient had a double direct inguinal hernia; both conjoined tendons were obliterated. The herniæ were of the type of small reducible bubonoceles. In this case both recti and their sheaths were transplanted, but the cord was left undisturbed. It was this recurrence that led me to return to the first method of transplantation of the cord, all but one by the Bassini method. It is too early to judge of the result. All of these patients are in service and have not yet returned.

Report of Case. In the following case I transplanted the rectus muscle and its sheath without transplanting the cord on May 20, 1918. The conjoined tendon was obliterated. The wound healed *per primam*, the patient entered the army as an

officer of the Quartermaster Corps. He was discharged from the army in December, 1918, and in February 20, 1919—ten months after operation—there was a definite recurrence in the lower angle of the wound. For about two weeks before the appearance of bulging there was definite local pain in the region of the external ring.

Anatomical Findings at the First Operation. The hernia was of the type of a small bubonocele. The patient was a white male, aged thirty-three, of good muscular development, a little over weight, and of sedentary habits. One could pass the index finger through a large and relaxed external ring directly over the pubic bone into the space of Retzius. The hernia had been observed eight months. No truss had been worn.

There was no hernia or weakness on the left side.

At this operation the external ring was found to be large and split, corresponding to the findings before operation. Above the cord there was a bulging between the internal oblique above, the edge of the rectus to the medial side, and the pubic bone below. This bulging was to the medial side of the deep epigastric vessel. The bulging was covered with fat. It could be easily seen and felt when the patient coughed or strained, as the operation was being performed under local anesthesia. There was no distinct sac. A triangular flap of the rectus sheath was turned down (Fig. 3), the internal oblique and rectus muscles were mobilized, and all of this tissue was sutured to Poupart's ligament by two rows of chromicized catgut. Then Poupart's was overlapped and sutured to the rectus sheath and internal oblique. Then the aponeurosis of the external oblique was folded over this line of suture and fixed to Poupart's. This is the usual method of imbricated suture.

In this case we had a small bulging of the type of a direct hernia. There was no evidence whatever of the conjoined tendon. From my observation this is the most difficult type of hernia to cure. When the bulging is small, the surrounding fascia and muscle have not been stretched and not thickened by inflammatory reaction, and although we attempt the so-called imbricated

suture, we are not able to get much of an overlap, because the tissues have not been sufficiently stretched.

It is in this type that I have had recurrences before in spite of a most painstaking suture and making the ring as snug as possible about the untransplanted cord.

Anatomical Findings at Second Operation. The recurrence was observed ten months after the first operation, and the second operation was performed two months later. The examination before this second operation was almost identical with that before the first. The finger invaginating the scrotum and following the cord passed over the pubic bone into the space of Retzius, but the tissues about the external ring were much thicker than before the first operation. The recurrent bulging and opening were above and to the medial side of the cord and admitted two fingers.

At this operation the wound having healed so perfectly, we could recognize and separate the anatomical structures just as clearly as in the primary operation. The recurrence was not due to any split in Poupart's ligament on the lower side, or any split in the rectus sheath or muscle on the medial side, but was a definite opening below the line of suture along the cord. At this second operation I transplanted the cord as in Halsted's method. That is, it lay between the subcutaneous fat and the aponeurosis of the external oblique. But I did not split the internal oblique muscle (Fig. 2). This was done, because the aponeurosis of the external oblique was somewhat thickened, and I felt that in view of the scar tissue the cord would be subjected to less pressure and would interfere less with the suture of the lower angle of the wound if I brought it out from the upper angle.

The results of the previous operation had produced thicker and stronger fasciæ and in the imbricated suture I was able to get a wider overlap. The sac in this case was not opened, but somewhat isolated and reduced. In my experience in small direct herniæ not much is gained by opening the sac, and when one pulls it out for high ligation there is some risk of injury to the bladder. I have no evidence to suggest that failure to open, partially excise and close a sac of this kind has anything to do with recurrence.

At this writing, about two and one-half months after operation the patient is at work and apparently well.

Subsequent to the first operation upon this patient in May, 1918, I have always transplanted the cord when the rectus muscle and sheath had been transplanted, because of the obliteration of the conjoined tendon, and have usually followed the Bassini method of transplanting the cord.

Conclusions. I have been induced to present this paper before the American Surgical Association, not because the problem of the cure of this type of inguinal hernia is settled, but because of the apparent indifference of the majority of operators to make any change in the technic of their usual procedure, when there is every evidence that the chief weakness is in the lower angle of the inguinal canal due to the obliteration of the conjoined tendon, and not in the usual position, in the upper angle where the cord is situated, and through which the testicle descended.

I have read most of the contributions by surgeons operating in our various training camps for the cure of hernia in soldiers, and thus far I have failed to find a single mention of any change in the technic or of the conjoined tendon, or the transplantation of the rectus or its sheath.

I am confident that this anatomical defect is largely responsible for our recurrences, although these may be relatively few. Some definite change in technic must be made before the number of such recurrences is materially reduced.

There should now be an unusual opportunity, because thousands of men in the selective service and soldiers have been subjected to the operation for the cure of inguinal hernia.

The Transplantation of the Sartorius Muscle for the Cure of Inguinal Hernia When Poupart's Ligament has been Destroyed. I observed some years ago that to completely excise the glands in the groin for primary or metastatic malignant disease, it was usually essential to completely excise that portion of Poupart's ligament corresponding to the inguinal canal.

In three cases of extensive cancer of the penis with metastasis

to the glands of both groins, I removed by *en-bloc* dissection the penis, both testicles and cord, Poupart's ligament, everything in the inguinal canal and Scarpa's triangle. To fill the defect left by the removal of Poupart's ligament I divided the sartorius in the middle of the thigh, isolated it except at its upper attachment, placed it over the inguinal canal and sutured it in place.

One of these three patients is living more than five years since operation. There is no hernia on the right side; there is a small bulging and opening on the left side, which gives the patient no discomfort. This case appears to be a pretty good test of the value of this muscle transplantation.

More recently, in two cases of malignant pigmented mole of the leg with metastasis to the glands in one groin I performed the identical operation, except that the cord was not excised, but at least one-half of Poupart's ligament was excised from the pubic bone. One of these patients—an officer in the army—returned to full duty in the infantry. There is no weakness in the scar and no interference with the function of the limb. The result in the second case is equally good.

It has recently occurred to me that this muscle could be utilized in some rare cases of recurrent inguinal hernia in which Poupart's ligament has become practically obliterated by previous operation but I have had no opportunity to carry out this idea since it occurred to me.

Note on the Transplantation of the Cord. In the great majority of inguinal herniæ where the conjoined tendon is wide and firm and where the internal oblique muscle is well developed and can be mobilized, there seems no difficulty in making a suture without disturbing the cord, or ligating the veins, and the careful study of the results in these cases demonstrates the correctness of this statement.

I feel confident, as already brought out in this paper, that when the weakness in the inguinal canal is in the lower angle due to the obliteration of the conjoined tendon, a proper suture for a permanent cure can only be done by separating the cord from its attachment and transplanting it either by the Bassini or Halsted method.

There will also be a few other cases in which it would seem safer to transplant the cord. In this group the conjoined tendon will be wide and firm, but the internal oblique muscle will be found to be attenuated and very difficult to mobilize.

I have just operated on such a case. The patient had been operated on for appendicitis and drained some twenty-six years ago. One year later a second operation was performed for hernia in the scar. About one year after this second operation a right inguinal hernia developed which finally became scrotal and during the past year difficult to reduce.

Operative Pathology. The patient was stout, the subcutaneous fat thick and adherent to the aponeurosis of the external oblique. The external ring was not very large, nor was the aponeurosis of the external oblique relaxed. The sac contained omentum adherent to the fundus of the sac. The omentum was ligated and reduced through an opening which hardly admitted two fingers. The remainder of the sac and omentum was removed. The cord in the inguinal canal was larger in diameter than a man's thumb. The internal oblique muscle was attenuated, largely replaced by scar tissue and practically immovable. The conjoined tendon was wide and firm. Poupart's ligament was thickened by scar tissue. This cord was unusually large, and in my experience would act as a factor in recurrence in either the upper or lower angle of the wound. The size of the cord was reduced by isolating, ligating and excising all but the vas and a few accompanying vessels. This mass was composed of numerous thick-walled veins and scar tissue, much larger than the usual varicocele. To excise this mass of veins it was necessary to isolate the entire cord, so that the vas with its remaining vessels could either be left in the lower angle of the wound or transplanted. I found that I could make a better suture of the lower portion of the wound by transplanting the vas, which I did according to Halsted's method, as the aponeurosis of the external oblique was too attenuated to allow a good covering by the Bassini method.

It is of interest and importance to note here that when I reported on the results in the Halsted clinic in 1899, we were unable to find

a single recurrence in the group in which the cord had been transplanted and reduced in size by the excision of the veins, and in which the conjoined tendon was wide and firm. The only objections to this method were a very few cases of atrophy of the testicle and hydrocele. But in my contribution I demonstrated that atrophy of the testicle depended upon hemorrhage from the lower stump of ligated veins, and with good technic the veins could be excised without any danger of atrophy of the testicle. But there is always the possibility of a hydrocele.

There should be no question in the mind of the surgeon or the patient that it is better to run the risk of a hydrocele than of a recurrence of the hernia, and I am confident from my experience that in some cases of inguinal hernia the cord should be reduced in size by a most careful ligation and excision of the veins, and in a small group the lower portion of the wound can be closed better by the transplantation of the cord. So far as I am able to observe, it makes very little difference whether this is done by the Bassini or by the Halsted method.

POSTINFLUENZAL ABSCESS OF THE SHEATH OF THE RECTUS MUSCLE

By HOMER GAGE, M.D.
WORCESTER, MASSACHUSETTS

The most important complication of surgical interest which was met in the epidemic of influenza last fall, as it was the most common, was undoubtedly empyema. Opportunity for its study and observation was not wanting in any community, and reports have already been published from many quarters.

But the grouping of many thousands of cases under one roof and under the care of the same staff in the army hospitals afforded an unusual opportunity to observe some of the less frequent but no less interesting complications. Chief among these in our experience at the Base Hospital at Camp Devens was a group of localized abscesses situated for the most part in tissues about the joints and in the muscles of the trunk.

There were three about the ankle, three about the shoulder, two about the elbow and one in the popliteal space. None of them communicated with the joint cavity primarily, and in only one case was there extension into the joint secondarily—that was in an abscess over the outer malleolus in a colored man who was suffering at the same time from a postinfluenzal psychosis, and in this case instead of leading to disorganization of the joint the process ultimately healed, with restoration of good function.

These abscesses appeared in the second or third weeks of the disease, in some even later, and were characterized by swelling and tenderness, but no redness; joint motion was very painful and the appearance as well as symptoms suggested joint involvement.

All of those in which bacteriological reports are recorded showed pneumococci in smear or culture or both, and all recovered promptly under simple incision and drainage.

The point to which I wish particularly to call attention in these cases is that they represent a pneumococcus infection

confined to the peri-articular tissues, not affecting the bones or joints, and not appearing in the viscera which are the common seats of metastatic processes.

Of even greater interest were three cases of abscess in the sheath of the rectus abdominis muscle, interesting not only on

account of their location but especially because we felt that we could trace their development through the various stages.

The first case occurred in a white male, aged twenty-one years, who entered the hospital on September 16 with influenza; he had a definite pneumonia, apparently confined to the lower lobe of the right lung. At the end of the second week in October, when satisfactorily convalescent from pneumonia, he complained of pain and tenderness in the lower abdomen, and on October 19 presented a definite globular swelling just above the pubes, elastic, not movable. It suggested a large tense bladder, and when that was ruled out it was still believed to be intra-abdominal.

The temperature was not above 100.5°, and the patient presented no signs of general sepsis. Incision revealed a large abscess in the sheath of the recti muscles which healed promptly under simple drainage. The bacteriological examination showed pure culture of pneumococcus Type I.

The second case was in a colored male, aged twenty-five years. He was admitted on September 12 with diagnosis of influenza and had pneumonia of the left upper and right lower lobe. During convalescence on October 29 he developed a swelling in the midline between the umbilicus and the symphysis, with slight pain, tenderness and fluctuation. Temperature was unaffected. At operation several ounces of pus were evacuated from the lower end of the recti, the culture from which revealed pneumococci, which were not typed.

The third case was a white male, aged twenty-four years, who entered the hospital September 28 with influenza, developed a pneumonia of the left lower and right middle and lower lobes, and was followed by an empyema of the left side. Pneumococci Type I were found in the sputum and in the pleural exudate. On November 10 he had a submammary abscess of the right side, from which staphylococci and streptococci were recovered on culture, which healed within a few days after being opened.

His general condition was good and there were no indications of general sepsis. On November 27, two months after his initial infection, he developed an abscess in the sheath of the rectus just

above the symphysis, containing a few ounces of thick pus yielding on culture pure pneumococcus Type I. Recovery was uneventful and prompt.

A quite similar case has been brought to my attention by Dr. W. E. Ladd, of the Boston Childrens' Hospital, which occurred in his service last winter, and through his kind permission the records have come into my possession.

It was that of a girl, aged ten years, who was admitted December 8 with influenza; additional diagnosis, pneumonia of the right upper lobe, with return to normal temperature on December 20, then had suppurative otitis media, not severe, and on January 8 complained of pain and tenderness in the lower abdomen. Incision revealed an abscess confined to the recti muscles containing Gram-positive streptococci which healed without complication.

The last case differs from the others only in that the infecting organism was a streptococcus instead of a pneumococcus. When we remember that the influenza bacillus is soon overwhelmed by the secondary invasion of the pneumococcus or the streptococcus or both, the similarity with our own three cases seems perfectly evident.

In these four cases we find influenza followed by a secondary infection limited to the recti muscles without any of the general symptoms or of the multiple lesions that usually accompany pyemic processes. We are at once reminded of the degeneration of the abdominal muscles, which has been often noted as a complication of typhoid fever, first described by Zenker in 1864 and bears his name, and which has been fully described by our own Dr. Keen in his Toner Lecture, on the "Surgical Complications of Typhoid," in 1876.

In a series of autopsies performed during the influenza epidemic at Camp Devens, by Dr. S. Burt Wolbach, lesions precisely similar to those described in typhoid were noted in nine cases. They ranged from a swollen opaque yellowish-white appearance to the presence of large masses of blood clot occupying considerable areas of the recti muscles. The following extracts from the autopsy reports show the extent of the observed lesions:

CASE I.—September 30. H. N. R.

Recti for 8 cm. above the pubes are swollen and infiltrated with blood clot and the muscle is softer and more friable than normal.

CASE II.—October 1. J. C.

Recti from the umbilicus to the pubes swollen and the upper half of each is infiltrated with dark red blood clot. Fibers are widely separated and there are cavities 0.5 to 1 cm. in diameter filled with clot. Pubic ends of muscles are pale, opaque and friable.

CASE III.—October 3. E. G.

Lower 8 cm. of recti opaque, pale yellow, friable, and in the left small areas of hemorrhage, 0.2 to 1.2 cm. long, separating muscle fibers at junction of normal and yellow portions.

CASE IV.—October 4. G. P.

Lower 8 cm. of both recti swollen, opaque, yellowish white and friable.

CASE V.—October 4. M. L.

Muscles of abdomen and chest normal except the lower end of the left rectus is opaque, yellowish and slightly swollen for a distance of 2 cm.

CASE VI.—October 7. C. W.

Upper ends of recti streaked in pale grayish-red lines and on the right side are punctate hemorrhages.

CASE VII.—October 8. F. Le C.

Lower ends of both recti from the umbilicus to the pubes greatly distended with dark red blood clot, and the retroperitoneal tissue on each side is infiltrated with blood for a distance of several cm. Muscles on section are soft, paler than normal with large masses of blood clot separating fibers longitudinally and occupying spaces between transverse tears of the fibers.

CASE VIII.—October 11. A. H.

Lower one-half of rectus contains yellow opaque areas in the form of striæ; on section portions of the muscle 1 to 2 cm. in length and 0.5 cm. in width are greenish-yellow in color, opaque, small areas of hemorrhage in muscle substance. Similar conditions at the upper end of the right rectus.

CASE IX.—October 11. W. J. E.

Recti at extreme ends pale reddish gray or pink; no hemorrhage.

In the microscopic study of sections of muscle removed at autopsy, Dr. Wolbach informs me that similar changes, though much less marked, are present in the other abdominal muscles, and in the other muscles of the trunk, such as the pectorals and the latissimus dorsi, though rupture of the muscle with accompanying hemorrhages, except microscopic, was not observed.

It seems probable that an abscess occurring beneath the lower angle of the scapula following influenza and operated on before our attention had been drawn to these muscle changes was of the same character, but it has not been included because its exact nature was not recognized.

From these observations it seems quite clear that a Zenker degeneration of the recti muscles is a not infrequent accompaniment of influenza and influenza pneumonia, that the muscle fibers become so friable that rupture occurs with varying degrees of hemorrhage, and that more rarely still the blood clot may be infected by means of the predominant organism with resulting abscess.

These cases of secondary infection, those alluded to in the earlier part of this paper, as well as those limited to the recti muscle, suggest one problem of more than mere speculative interest.

Is there a definite selective action on the part of different organisms or different varieties of the same organism for different tissues as claimed by Rosenow?

Our observations at Camp Devens showed that we were dealing with an organism that attacked the pericardium frequently but not the endocardium; the structures around the joints, but not the bones or the joints themselves; the striped muscle but not the unstriped; connective tissue, but not glandular; the abdominal wall, but not its contained viscera. Although satisfactory proof, of course, to the contrary is still wanting, it hardly seems as if this selection could be accidental.

DISCUSSION

Dr. Ernest A. Codman, Boston:

I had the opportunity at Camp Taylor of seeing a good many of these cases about which Dr. Gage has been speaking. I believe that these abscesses following influenza are a distinct clinical entity, and I am glad the subject has been brought up. I believe also that these conditions arise sufficiently frequently to make Dr. Gage's paper one which everyone should read, for we all should be on the watch for such complications in the next epidemic.

At Camp Taylor we had perhaps a dozen of these cases. They occurred most often in relation with the abdominal recti and with the glutei. Although they penetrated and destroyed these muscles to some extent, it did not seem to me that they were abscesses of the muscles themselves, but rather primarily phlebitis of the adjacent veins, such as the epigastric. We had numerous cases of general hemolytic streptococcus septicemia, and the occurrence of these abscesses was as characteristic a manifestation as empyema or mastoiditis. At the onset it was difficult to tell whether the trouble was intraperitoneal or in the abdominal wall. Later the diffuse soreness would become localized enough to determine the site of incision. I learned to be very cautious about opening the peritoneum in these atypical cases. Abdominal spasm during an influenza epidemic does not have the significance it does in ordinary times.

Dr. William Darrach, New York:

Of three cases of postinfluenzal abscess seen in the Army of Occupation, two were diagnosed as intra-abdominal conditions, but proved to be instances of abscess in the sheath of the rectus muscle. The third case was diagnosed before operation. All three cases showed hemolytic infection on culture. Autopsy in many cases dying from pneumonia showed hemorrhage in the muscle rather than in the region behind the muscle. I do not remember any case showing phlebitis of the hypogastric veins.

THE RESULTS OF SPLENECTOMY IN THE ANEMIAS

By WILLIAM J. MAYO, M.D.
ROCHESTER, MINNESOTA

Splenectomy as a curative agent has been given a fair trial in three types of the anemias, and its successes and failures may be reasonably shown by the data at hand. It is my purpose to discuss the operation in cases of splenic anemia, pernicious anemia and hemolytic icterus from this standpoint.

Splenic Anemia. While splenic anemia is, as pointed out by Osler, a clinical entity, it cannot be said to have a definite pathologic existence. It may be defined as a splenomegalia, with a secondary type of anemia which is progressive but not constant until the later stages. This secondary anemia has no special characteristics except that, as a rule, it is accompanied by a leukopenia, although we have seen otherwise typical cases in adults with leukocyte counts from 10,000 to 12,000. Splenic anemia was designated by many of the early observers splenic pseudoleukemia, and it is believed by some clinicians of the present day that von Jaksch's disease (infantile pseudoleukemia) is an infantile form of splenic anemia in which a moderate leukocytosis due to the higher values of leukocytes in the normal blood of infants is to be found.

A number of pathologic conditions of the spleen which more or less resemble splenic anemia have been classified as splenic anemia, especially that of syphilitic splenomegalia. A few clinicians regard all splenic anemias as syphilitic in origin, but this theory is not borne out by our experience. Chronic enlargements of the spleen that are accompanied by anemia and are the

result of various protozoa, syphilis, malaria, kala-azar, etc., as well as those anemias due to bacteria, typhoid and tuberculosis, were removed from the splenic anemia group when their etiology was discovered.

Hemolytic icterus has often been confused with splenic anemia. Occasionally pernicious anemia, when accompanied by a large spleen, has been diagnosed splenic anemia. Put in the form of a Hibernianism, incomplete knowledge is essential to the diagnosis. If we know the cause of splenic anemia it is not splenic anemia. It is a question, however, whether we have not been too insistent on the lack of knowledge, as evidenced by unknown etiology, as one of the chief features of splenic anemia. I believe we would get a much better idea of splenic anemia if we made the pathologic condition of the spleen and its effect on the blood the criteria, and classified as splenic anemia all cases of known causation as well as those of unknown causation, assuming that in the course of time we shall find the toxic agents which produce this condition of the spleen.

The pathologic characteristics of the spleen in splenic anemia are generalized fibrosis, with compression atrophy of the Malpighian corpuscles, and endophlebitis. It may be said that enlarged spleens that show such characteristics will develop chronic anemia without regard to causation. In five instances we removed large spleens in cases of chronic intractable syphilis, with severe anemia, in which the patients had been carefully treated for syphilis for months. After the removal of the spleen the anemia rapidly disappeared and the syphilis was cured with comparatively mild antiluetic treatment, such as had previously failed to affect either the syphilitic condition or the spleen. In three of these cases gummas were found in the liver, in two small gummas were found in the spleen, and in two the spirochete was stained in the splenic tissues.

In 1883 Banti first described an enlargement of the spleen accompanied by atrophic cirrhosis of the liver of the Laennec type. The relation of splenic anemia to Banti's syndrome is most interesting. The majority of clinicians, I believe, agree with

Moschcowitz in the conclusion that there is no real difference between the two and that Banti's disease is merely a late phase of some cases of splenic anemia. It is certainly true that a considerable percentage of cases of splenic anemia in the later stage will be found to be associated with portal cirrhosis of the liver, but not always of the atrophic type; the liver is as frequently enlarged as contracted. On the other hand, some observers believe that all cases of this description are primarily portal cirrhosis and that the splenomegalia is secondary. When the condition is seen in the later stages it is difficult if not impossible to determine whether it was primarily portal cirrhosis, with secondary splenic manifestations, or primarily splenic anemia.

Gastro-intestinal hemorrhages, especially hematemesis, and ascites occur in splenic anemia and in portal cirrhosis. After all, cirrhosis of the liver is essentially a fibrosis which exhibits more fixed characteristics than the spleen because the liver cells are all of one type and react uniformly to chronic irritation, while the spleen has differentiated groups of cells which permit of wide architectural changes. It is also to be noted that the blood comes directly in contact with the splenic pulp, as the vessels retain only their endothelial coverings; this may account for the endophlebitis which is so marked a characteristic of splenic anemia. Occasionally an enlarged spleen will be found, especially in women, without known cause and without anemia. This condition may exist for years, but eventually anemia results. In several cases of this type when the patients finally came to operation the spleen was fibrotic. It is probable that fibrosis of the spleen from any cause will eventually produce chronic anemia, and, other things being equal, such spleens should be removed when appropriate treatment fails to cure.

Of 61 patients with splenic anemia from whom we removed the spleen, 7 (11.7 per cent.) died.[1] The deaths occurred in patients operated on in a late stage of the disease, in which there was a

[1] These statistics extend to December 31, 1918, and include as operative death all patients dying in the hospital without regard to cause of death or length of time after operation.

high grade of anemia, ascites and cardiorenal manifestations. In 3 patients acute thrombosis of the superior mesenteric and portal veins was the immediate cause of death; extensive thrombosis, evidently of long standing, was found in the splenic veins. These observations are in accord with those of Dock and Warthin, who found extensive thrombosis of the splenic vein in two patients who died from splenic anemia. These patients had ascites without cirrhosis of the liver. It would appear that the spleen, acting as a filter, removes noxious agents, both microörganisms and chemical toxins, from the blood stream and sends them to the liver for destruction; in certain instances cirrhosis of the liver as well as fibrosis of the spleen result from the chronic irritation produced by such substances. If the spleen is unable to rid itself of all these toxic agents, splenomegalia and anemia result with sequestration of the agents in the spleen, as in spirochetal and plasmodial infections, but the liver is not necessarily cirrhotic. Why the liver is cirrhotic in some cases and not in others is not known.

Both portal cirrhosis and splenic anemia lead to death through portal obstructions, and the hemorrhages and ascites are due to back pressure. If the spleen is removed early in splenic anemia we know by experience that the liver will probably not show serious evidences of disease later, and even when cirrhosis of the liver is well marked and ascites is present, removal of the spleen often effects a "near" cure. The first thought is that by removing the spleen toxins filtered from the blood are prevented from passing to the liver. On further consideration it seems that the true explanation is this: Inasmuch as the normal spleen carries about 30 per cent. of the blood to the liver and that from these huge spleens the splenic vein may carry as much blood to the liver as the remaining elements of the portal vein, splenectomy relieves the liver of its overload and reduces its labor sufficiently to enable it to meet its demands, just as sometimes follows the Talma-Morison-Drummond operation. Fagge, many years ago, described a series of cases in which persons apparently in perfect health, coming to their death by accident, proved at necropsy

to have advanced cirrhosis of the liver, but with so good a compensatory circulation along the vascular channels of Sappey as greatly to reduce the circulation in the liver and enable it to maintain its function.

Many patients splenectomized in the late stages of the disease, with marked ascites and frequent hemorrhages from the stomach, etc., have been cured. Balfour, in a recent article on gastric hemorrhages of splenic origin, reports in detail a case in which the removal of a spleen a little larger than normal, checked gastric hemorrhages of many years' duration, from which the patient was almost exsanguinated. The patient has remained well now for nearly three years. We have since had a similar experience: A patient *in extremis*, for whom repeated blood transfusions failed to afford even temporary relief, was cured by splenectomy. Sherren and others have called attention to the fact that after the removal of the spleen for splenic anemia an occasional patient has a recurrence of hemorrhages. We have had one case of this kind, but such experiences are unusual. I would call attention to the important fact that in five of these cases the diagnosis of splenic anemia was not definitely established, but the five cases fitted into this group better than into any other. Future progress in knowledge of splenic conditions may change the interpretation of the facts and alter the diagnosis.

Pernicious Anemia. The etiology of pernicious anemia is unknown, the early symptoms are indefinite and by the time the diagnosis can be made the disease is incurable. The disease may be described as a progressive degeneration of the red blood in which there is a loss of the blast or mother cells of the erythrocytes; the blast cell when lost is not replaced. In contrast to splenic anemia which is of the secondary type the blood picture in pernicious anemia has characteristic cells which mark the disease. The color index, or hemoglobin percentage, is higher in proportion to the number of red cells present than in the secondary anemias. The lemon color of the skin, sometimes with an icteroid hue, is so different from that in the secondary anemia that sometimes a diagnosis is possible by looking at the patient.

This icteroid hue is more prominent in cases in which hemolysis is marked, as shown by examination of the duodenal content after the Schneider method. If we might assert that in cases of pernicious anemia in which hemolysis is most marked patients have a greatly enlarged spleen or that the spleen exhibits definite pathologic changes we would have succeeded in establishing a direct connection between the enlarged spleen so often found and the disease. Unfortunately our experience does not support this hypothesis and the size of the spleen does not seem to bear a definite relationship to the severity of the disease. Necropsy, after death from pernicious anemia, as a rule, shows a small spleen, but in two only of our cases was the spleen below normal (195 grams, Sappey) at operation, and both were terminal cases.

The average weight of the spleens removed in our cases of pernicious anemia was 400 grams, exclusive of two large spleens, one of which weighed 2220 grams and the other 1600 grams. It seems probable, therefore, that in pernicious anemia the spleen is enlarged during the early and middle stages and that the contraction so often found at necropsy is a terminal condition. The question is as yet unanswered whether pernicious anemia is a definite and specific entity or whether it is a terminal change of several conditions and recognized only as pernicious anemia when the patient has reached a stage which we know will eventually cause death.

Any form of treatment for pernicious anemia may prove, or at least may appear to be, beneficial. Even without treatment these patients have their ups and downs, and it is not an infrequent clinical experience to have a patient present himself with symptoms which might be construed as being those of an early pernicious anemia, and then with or without treatment recover and remain well. In eliciting the history the physician finds that the symptoms are often indefinite in the earlier stages before the blood changes become characteristic.

Splenectomy in pernicious anemia does not appear to be based on sound reasoning, and there seems to be no foundation for the belief that the procedure will cure pernicious anemia. Eppinger

first suggested splenectomy as a cure for pernicious anemia, and the early reports with the abundant testimony as to temporary relief were quite sufficient to give the operation a fair trial in this hopeless disease. Considering the confusion which so often attends the early diagnosis, it seems probable that obscure cases of hemolytic icterus and splenic anemia have been accidentally included in the pernicious anemia group. Removal of the spleen in such cases has given the impression that splenectomy cures pernicious anemia. At the same time in the investigation of our cases of splenectomy for pernicious anemia we see great though temporary improvement. There is a gain in weight and an improvement in the blood from an average hemoglobin of 38 to 72 per cent., and the reds from two to four millions. Splenectomy seems at least to have instituted a marked palliation.

In our experience in the cases in which the results were most favorable the symptoms were less characteristic of pernicious anemia. In young and middle-aged persons in whom the disease is most rapid, especially if hemolysis is shown to be marked, splenectomy is worthy of trial. Taken as a whole it may be said that whenever pernicious anemia has developed to the stage in which the blood is characteristic it is incurable and splenectomy is a means of palliation and not of cure. Since there is an operative mortality, good reasons must exist for substituting operation for repeated blood transfusions. We have splenectomized 50 patients with pernicious anemia, with three deaths (6 per cent.).[1]

Hemolytic Icterus. Hemolytic icterus has not been classified with the anemias, but, as pointed out by Kanavel and Elliot, the peculiar splenic activity results in an anemia which is the cause of death. As in splenic and pernicious anemias the etiology of hemolytic icterus is unknown. The well-developed case of hemolytic icterus stands out with a vividness unequalled in splenic anemia and in pernicious anemia. These three diseases, all of unknown etiology and lacking sound pathologic foundation, when examined in the minutiæ are without distinctive features. Viewed in the perspective they are outstanding clinical entities.

The characteristic features of hemolytic icterus are an enlarged spleen, chronic jaundice with exacerbations, normally bile-colored feces and absence of bile in the urine.

It is certain that in hemolytic icterus the spleen destroys, unnecessarily, the red corpuscles; the enlargement of the spleen may be in the nature of a work hypertrophy. Enlargement of the liver is usually present and may also be a work hypertrophy. In some of our cases sections from the liver showed definite hyperplasia of liver cells.

There are two types of hemolytic icterus: the familial or congenital type of Minkowski, and the acquired type of Hayem and Widal. In the familial type the disease may be noticed from infancy, and it may not be progressive; the patients live the allotted span of years in a fair degree of health, but with more or less jaundice throughout life. These cases are not uncommon and are to be seen in every community; a large percentage develop a more serious condition, which makes them indistinguishable from the acquired type, and, like the acquired type, the disease progresses in the course of some years to a fatal ending.

Chauffard and Widal have pointed out that the red cells are less resistant in hemolytic icterus than normally, and our experience confirms these observations. Sanford has worked out a simple and very reliable method of examination for red cell fragility which we have used in the clinic extensively, and with great satisfaction.

The Relation of Hemolytic Icterus to the Liver and its Cirrhoses. We find in hemolytic icterus an occasional case in which biliary cirrhosis is associated. Brushing aside the familiar classifications of the cirrhoses of the liver in which variations in the morphology lead to unnecessary confusion, there are but two fundamental hepatic cirrhoses: (1) The portal, in which the toxic material reaches the liver by way of the portal vein, and in which the connective tissue is deposited about its radicals and death is caused by portal circulatory obstructions, ascites, gastro-intestinal hemorrhages without jaundice until shortly

before death, etc., and (2) biliary cirrhosis, caused by an infection of the biliary ducts, in which the connective tissue is deposited about the biliary ducts, causing jaundice but without ascites or hemorrhages until shortly before death. More often this is an ascending infection from associated gall-stone disease, especially gall-stones in the common duct; at times it is hematogenous from focal infections in any part of the body; the pancreas is frequently associated in a chronic pancreatitis. Just as we have many varieties and subvarieties of portal cirrhosis, so we have many varieties and subvarieties of biliary cirrhosis, but we should not be led astray by the many patterns which may appear any more than we should name wall-papers or carpets differently according to their patterns. Normally blood pigments are the source of the coloring matter in the bile. In hemolytic icterus the enormous destruction of red corpuscles in the spleen inundates the liver with blood pigments and renders the bile thick. One can conceive that, under such circumstances, a liver which has a superabundance of work of a certain kind thrown upon it may deposit pigments throughout its tissue, thus producing many of the patterns which are given as varieties of biliary cirrhosis. As there is no infection there is no cirrhosis, but there is, as I have stated, some enlargement of the liver.

The viscid bile in hemolytic icterus tends to form gall-stones. Sixty per cent. of all the patients with hemolytic icterus on whom we operated had associated gall-stones and all the possibilities of biliary-duct infection. It may readily be understood why biliary cirrhosis is sometimes associated with hemolytic icterus and why the two diseases have been confused. It should not be forgotten that in portal cirrhosis and in biliary cirrhosis the entire liver may not be involved in the cirrhosis. We frequently see limited areas of cirrhosis without attending symptoms because the organ is not extensively involved. Hemolytic icterus has been most often confused with the elusive syndrome termed Hanot's cirrhosis, which, so far as I know, has no pathologic foundation, and if it occurs clinically I have never seen it.

The triumph of splenectomy is the cure of hemolytic icterus.

We have had no more satisfactory results in surgery than are to be found in this group of cases. Only patients in a terminal condition with secondary gall-stones and cirrhosis of the liver fail to be relieved. The only patient we lost of the twenty-seven splenectomized for hemolytic icterus was one operated on during an acute exacerbation. Crises are a part of the picture of the disease, and when severe have usually been due to gall-stones, although it is undoubtedly true that exacerbations do take place from unknown causes in which there is great but temporary increase of jaundice, with tenderness and increased tumefaction of the spleen, and usually of the liver, without gall-stones. On gross section the spleen in hemolytic icterus is dark, mottled, filled with blood pigments and quite distinct from the spleens which we have removed for other conditions.

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TRAUMATIC FACIAL DIPLEGIA

By JOSEPH RANSOHOFF, M.D., F.R.C.S. (Eng.)
CINCINNATI, OHIO

One-sided facial palsy is surely of common occurrence. The synchronous involvement of both sides of the face by palsy is exceedingly rare. There is no way of determining the relative frequency of un lateral and bilateral facial paralysis, but in my investigation of the subject I found that many neurologists of large experience have seen no cases of the latter. As the most common cause of the condition, multiple neuritis easily comes first. In a very excellent article by Patrick,[1] the author added 29 cases, some of his own, and others from literature, to 19 cases previously collected by Laurans,[2] but Patrick believes that quite a number of the earlier cases reported are apocryphal. As I will show, similar doubt applies to cases reported as traumatic.

Facial diplegias have likewise been recorded as a result of diphtheria by Ross, 5 cases, and 4 after influenza. It is evident that quite a number have been reported as the result of double otitis media, and mastoid disease. In a few instances, bilateral so-called rheumatic paralysis of the face has been observed (Bell's palsy). A most interesting case of this nature was reported by Throckmorton,[3] in which there was an interval of six or seven days between the inception of the paralysis on the two sides.

A very interesting bilateral facial paralysis of syphilitic origin was quoted in French by Sir Charles Bell.[4] It was that of a young woman of sixteen, with a little tumor of the left frontal region. The day after her admission, November, 1828, the left side of the face was completely paralyzed, the tongue a

little stiff, and speech embarrassed. The mouth was forcibly drawn to the right side. Eight days after the appearance of the left-sided paralysis, the same symptoms developed on the right side, the tongue was not affected. The eye-lids could not be closed, and the tears welled down on to the cheeks. The lips were flabby, and moved like curtains on expiration. The patient did not suffer in any way. One could hear her in fits of laughter, but she laughed as behind a mask. Under antisyphilitic treatment this patient recovered. I present this case because it is interesting to note that it came from the Hotel Dieu, and the service of Dupuytren, who, sixteen years later, while in the amphitheatre of the hospital, himself suffered from a facial paralysis, which was due to a slight cerebral hemorrhage, that caused his death a year later. The great Cruveilhier made the autopsy.

Peripheral facial paralysis has likewise been observed in infants, as the result of difficult parturition and the use of forceps (Romberg[5]).

The earliest extensive report on facial diplegia appeared in 1901 by Sainton.[6] Of the entire number of cases, only three were said to be of traumatic origin, namely, those of Gama, Romberg and Koslovsky. The cases of Gama and Romberg must be excluded from the traumatic cases, since in neither of them is there any evidence of the involvement of both facial nerves.

By way of digression the case of Gama,[7] is interesting, for, according to the patient's statement, two bullets, coming in opposite directions, "whizzed" close to his head. "The shock of these bullets (the patient stated) distinctly struck my ears, and I became unconscious. I was roused from my lethargy by the pain which the Cossacks caused me while robbing me. When I recovered I was entirely devoid of speech, blood flowed from my mouth, from my nose and from my ears, but I recovered. With the rest of the prisoners I traversed Germany, Poland and Russia. There was a profuse bloody discharge from both ears, and this continued for eighteen months, when it finally ceased." Hearing was lost on both sides, but the lips lost none of their

mobility. It is evident, therefore, that whatever may have been the primary lesions in this case, and whether or not they were produced by the vibrations of passing bullets, it is impossible to see anything in it like the traumatic paralysis of the portio dura of the seventh nerve.

A similar doubt must be placed upon the quotation from Romberg. The only case of double paralysis which I can find there was that of a man of forty, with a very decided venereal history.

It is probable that in rapidly fatal basal fractures, with general muscular relaxation, facial diplegias occasionally occur, and that they are overlooked because of the difficulty of recognizing them, and the apparent hopelessness of the cases from a prognostic viewpoint. At any rate, I have not seen such cases, nor am I cognizant of any reference to them in the literature at my command. The cases of traumatic facial diplegia are therefore very few. Indeed, I have been enabled to find records of only four. I believe myself justified therefore in giving brief abstracts of these cases.

The case of Koslovsky,[8] then, is the only one of true traumatic facial diplegia which I have been enabled to find reported up to the outbreak of the war, and it was reported in 1892.

Case I (Dr. B. C. Koslovsky[8]).—Private J. J., while carrying logs from a boat to a landing, fell into the water, a distance about ten feet, and was struck by a log over the left half of the head. When brought into the hospital he was bleeding from both ears and nose and vomiting. Consciousness was retained, but speech was very indistinct. There was a large hematoma on the left side of the scalp. No other external injuries. Considerable headache. Temperature and pulse remained normal. The action of the pupils negative at first, but later became normal in the right eye. Left pupil was dilated, and did not react to light. There was constant and marked diplopia. Hearing very much lessened on the right side, entirely lost on the left. The tuning-fork could not be heard on this side. There was complete paralysis of both sides of the face.

All the symptoms detailed appeared simultaneously. After three months the paralysis of the face continued unchanged. The patient remained completely deaf in the left ear, while the hearing in the right was somewhat improved. Taste sense was at no time affected. When the patient was last seen it seemed probable that the condition as detailed at the last examination would be permanent.

Although there was no *x*-ray confirmation, the diagnosis of basal fracture could not be questioned. The injury to the facial nerves must have been above the geniculate ganglion from the undisturbed taste functions. It is probable that from the involvement of other cranial nerves the tear was above the entrance of the nerve into the internal auditory meatus of each side.

Case II (Oppenheim and Hallez[9]).—P. J., aged twenty-eight years, infantryman, injured October 27, 1916, by the bursting of a large shell in close proximity. There was immediate loss of consciousness, followed by prolonged amnesia. He could furnish no details as to how he was hurt. Consciousness returned sixteen hours later. The primary report states that there were no external lesions. Double facial paralysis, bleeding from both ears, profuse nose bleeding, slight mydriasis on the left side. After a day or two he became semi-conscious again, and when he recovered complained greatly of nausea and vertigo. Epistaxis and bleeding from one ear returned again. He entered the otological service two weeks after his injury for "concussion of the labyrinth, injury to the tympana, with infection on both sides and facial diplegia." The face presented the appearance of a blank mask, without any expression, the creases of the forehead and of the face having completely disappeared, and there was slight edema of both cheeks. There was no diplopia, and visual activity was normal. Speech was a little slow, scanning, and especially embarrassed by the pronunciation of the labials. Deglutition was normal.

It is interesting to note that after the first visit of the patient's wife, in consequence of a violent emotion, the man presented a complete mutism during four days. The cheeks were flabby,

mastication was considerably embarrassed because foodstuffs fell between gums and the cheek. The soft palate was lifted normally, and there was no deflection of the uvula. The sensibility of the tongue was conserved, but the sense of taste was abolished in the anterior two-thirds.

The electrical examination made in January, two months after the injury, showed a degeneration reaction of the seventh pair, a little more marked on the right than on the left side. The hearing on the right side was diminished, and there was an otitis media. On the left side hearing was quite gone, and there was suppuration of the middle ear. The facial and auditory nerves seemed therefore to have been involved, but no others were in any way injured.

The lumbar puncture made in January showed a clear lymphoid fluid, with a little more albumin than normal, and a scarcely appreciable increase of ce lular contents. The lesion, doubtless, therefore, was in the Fallopian canal, on each side. After several months' sojourn in the service, the patient improved considerably, the eyelids could be partially closed, and the forehead slightly furrowed. As to the cause of the paralysis, the authors are in doubt. It might have resulted from a fracture through the petrous portion of both temporal bones, or it may have resulted from an immediate intra-tubal concussion. It is possible also that the injured man was thrown backward and sustained a fracture of the base, through both temporal bones. In favor of this hypothesis are the nose-bleed, the repeated bleeding from the ears and the prolonged coma. In support of the possibility of the shock of the explosion alone causing the damage in the petrous portions of the temporal bones without fracture, the authors allude to two men, who, without any trace of external injury, or even of a fall, presented as a result simply of concussion, a total unilateral facial palsy.

Case III (Chatelin and Patrikios[10]).—The case, when presented, was one of six weeks' duration. There was a total or double paralysis of the peripheral type. On the left side the paralysis was absolute, while on the right there was an indication of very slight movement, in an effort to close the eye. The

aspect of the face was characteristic. The forehead was entirely without wrinkles, naso-labial folds had disappeared, the lips were half open, and the saliva drooled from the mouth. Speech was almost incomprehensible. Mastication was very difficult. Electrical examination showed complete reaction degeneration on both sides. The diplegia was the result of an accident. The wounded man was about to unload a heavily loaded wagon, when it was suddenly propelled backward and his head was caught transversely between the wall and the wagon. Released at once the man bled from the left ear. The diplegia manifested itself at once. For several days the face was very much swollen, and he had many ecchymosis in the temporomalar region. Eating was uncomfortable on account of the trismus. This, however, disappeared in a few days. The writer believes that the facial nerve was injured on both sides by a transverse fracture at the base of the skull, even if there were no actual symptoms of injured lesions of the organ of audition. It appears to the writer that in the absence of loss of taste and of the radiographic evidence of fracture of the base, in this case, it is more likely that underneath the ecchymoses described in the temporo-malar region, the facial nerves had been injured by compression after their exit from the stylomastoid foramen.

Case IV (L. Marchand[11]).—Soldier, aged twenty-two years, was thrown from an automobile truck on August 22, 1917. He had no recollection of how the accident occurred. There was immediate bleeding from both ears, epistaxis and bilateral facial paralysis. In the temporal region there was a contused wound. The patient was unconscious for forty-eight hours.

Diagnosis.—Fracture of the base of the skull. On the morning following admission there was a considerable palpebral and subconjunctival hematoma; there was also a hematoma at the nape of the neck. A lumbar puncture was made on the day of the accident, but in the original report no result of the examination is given. During six days the punctures were repeated. He was admitted to the Neurological Center at Bordeaux, on December 4, 1917, when the facial paralysis continued. The record states that the movements of the face are nil on both

sides. The patient cannot laugh, cry or whistle. Speech is difficult, on account of the inability to pronounce the letters B, P and M. Swallowing is normal, but to drink the patient must hold his head backward to prevent the liquids from running out of his mouth. The sense of touch and pain is normal, both in the tongue and the face. Salt, acids and sweets are not felt in the anterior two-thirds of the tongue on the right side, but the taste for bitter things is normal on both sides. In March, of 1918, there was some voluntary movement of the lower portion of the left side, and the left eye could be completely closed. There was still a loss of gustatory sense on the left side. On the right side the paralysis presents no improvement.

The following is the case I have been privileged to observe:

Case V.—Miss E. K., aged twenty-two years, injured January 4, 1919, in a street car accident. On entering the First Surgical Service at the Cincinnati General Hospital she was unconscious and bleeding from both ears. The coma, which was not deep, continued for over an hour, and was followed by vomiting. There were two general convulsions, lasting for about five minutes. Both convulsions were preceded by twitching of the right eye-lid, and the entire half of that side of the face. During ten days following the accident the patient suffered from severe headaches, with pain in the ear and nausea. Pulse on entrance varied between 82 and 90, and was of good quality. The temperature was normal.

On admission there was a slight contusion in the right frontal region, and an incised wound 5 cm. long in the midline. There was a complete left-sided facial paralysis, and a slight ecchymosis over both mastoid regions.

On the morning of the third day after admission, the right side of the face was found to be completely paralyzed. The neurological examination at this time by Dr. Hoppe shows that the patient was oriented for time and place. The facial expression is one of indifference, and there is a decided mental sluggishness. The right pupil is slightly larger than the left, and the left external rectus a little weak. All other eye muscles are normal. The

paralysis of the face is complete, the patient being unable to close either eye to the slighest degree, to move her lips or the wings of the nose. The face is mask-like, and the lips flap loosely on expiration. Owing to her inability to use the lips, speech is very indistinct. Facial expression which would result from an emotion is only expressed by the eyes.

Ear examination by Dr. Iglauer shows tinnitus in the right ear. Both drums are intact; there is no spontaneous nystagmus; Weber to the left. Bone conduction is normal. Whispered voice is heard at 8 feet in both ears. A lesion of the eighth nerve on either side can therefore be excluded. There is no hyperacousis.

An examination of the tongue shows that it can be protruded normally, in the midline, and moved from side to side. There is no deflection of the uvula. The sense of touch is normal. The gustatory sense is completely absent on both sides of the anterior two-thirds of the tongue. The patient is unable to taste sweets, vinegar, sugar or bitter things.

The *x*-ray examination and the stereoscopic plates show an oblique fracture through the cranial base, running through the left mastoid process into the petrous portion of the temporal bone.

According to the subsequent history the paralysis disappeared from the right side of the face in the course of two or three weeks, and during the next two months it had disappeared entirely from the left side. The muscular control returned first in the lower part of the face. First, a slight motion of the angle of the mouth, then of the nose and lastly of the eyelids. This progress of recovery occurred upon both sides. It is interesting to note that the presence of a partial paralysis and the manner of retrogression of a paralysis may be explained on the theory advanced by M. Moure, namely, that the facial nerve in the Fallopian canal is composed of two sets of fibers—the one peripheral or superficial, which constitutes further along the supply of the lower facial group of muscles, the other central or deep, which innervates the upper muscle group. The superficial fibers would, therefore,

be more exposed than the deeper ones to irritation and compression coming from the outside, and, therefore, there would be a slower return of the muscular power in the lower facial area. So far as I know, there has been no anatomic demonstration of this theory. In fact, the case reported substantially contravenes the hypothesis as set forth. The same lack of confirmation is made manifest by the case of M. Marchand. Nevertheless, the anatomic question is one of exceeding interest, and would well merit further study.

An interesting point is that in this patient there were two convulsions, each beginning with twitching of the right side of the face. This might lead to the belief that there had been some irritative lesion of the right nerve in the canal before the hemorrhage had set in. The slight weakness of the left external rectus could not be accounted for, and disappeared very rapidly.

Remarks. It is very evident that the lesion in this case, on each side, was in the Fallopian canal, below the geniculate ganglion, and at a point above where the chorda tympani is given off. It was also below the point where the nerve to the stapedius is given off, since there is no record of hyperacousis.

Although there was a fracture across the base of the skull, through the mastoid and petrous portions of the temporal bones, as shown by the ecchymosis behind the ear, it is quite certain that neither nerve was severed. Of the right nerve one can be sure of this, since the paralysis did not manifest itself until two days after the injury. Hemorrhage only could have accounted for this late occurrence. On the left side the paralysis was instantaneous, but since it completely and speedily recovered, it is likely that here also there was only a contusion with hemorrhage. Where there has been a complete severance in continuity, recovery after fracture is very uncommon, and if it does occur, does so only after the lapse of many months.

It is evident from the above that traumatic facial diplegia is an exceedingly rare condition, since I have been enabled to get only four other cases from the literature at my command. It is remarkable that all of these cases recovered, since, with the

possible exception of two of the cases, all of them presented evidences of basal fracture, and in one of these the basal fracture could not be positively excluded. In Case II, there is a possibility that the peripheral portions of the nerve, after their exit from the stylomastoid foramina were injured, since there was no record of the loss of taste.

In none of the cases recorded was a decompressive operation indicated in the judgment of the surgeons in charge. With the exception of one of the cases, on each side the lesion was in the Fallopian canal, although in our case hearing was not involved, whereas in some of the cases it is evident that from the loss of hearing the eighth nerve was included in the damage, either as a result of hemorrhage or of concussion of the internal ear.

Since the above was written, I have received a communication from Dr. Ernest Sachs, who reports the following case of traumatic facial diplegia from the Barnes Hospital.

Case VI.—The patient, aged sixteen, was admitted October 11, 1912. Motorcycle accident. There was bleeding from the right ear and the nose. No fracture could be made out by palpation. K. K. very active. No ankle clonus, and no Babinski reflexes present. The left eye somewhat dilated. Does not respond to light. Slight exophthalmos of the left eye. Pulse 138. Blood-pressure 135. Vessels in the eye ground are tortuous. Lumbar puncture could not be made. There is complete external rectus paralysis on the right side and a slighter one on the left. The orbicular muscle about the mouth cannot be used. He is unable to pucker his lips, nor can he whistle. It is evident that there is a bilateral facial involvement. Neither facial nerve reacts to faradism, and it is only with the strongest possible current that one can get contractions. Does not seem to taste quinine on the anterior part of the tongue, but does on the posterior. Salt and sugar are both recognized. When the patient sleeps, both eyes are completely closed, while when awake and told to close them he cannot do so. *X*-ray plates do not show a basal fracture. Just before the patient was discharged on October 11, it was noted for the first time that he was beginning to gain some use of the muscles about the mouth on the left side.

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LANTERN SLIDE DEMONSTRATION OF JAW SURGERY

By ANTOINE DePAGE, M.D.
BRUSSELS, BELGIUM

Two methods are used: (1) impression splints, and (2) metallic circles. The reduction in the use of the splints is not always so good because they are put on the teeth, the mouth necessarily being open. When the mouth is closed after putting the splint in place the splint constitutes a foreign body between the upper and lower jaw which prevents perfect coaptation. This second disadvantage is not so important because you can always remove the superior part of the splint so that the teeth may articulate.

The picture here shown is that of a fracture of the lower jaw with four fragments, each of which is fixed to a segment of the splint, each segment having a few hooks. When this is done the circles are fixed on the teeth one after the other; each fragment of the lower jaw is brought close to the superior jaw and fixed by the hooks. When the reduction is perfect all the different segments are soldered together. Wires hold the two jaws in position and the next day the patient is able to open the jaws to eat. If reduction is done very early there is no contracture of the jaw. Since this method has been employed I have had no cases of contracture. In cases with loss of bone substance and in which there may be displacement when the patient is eating, there is fixed to the circle a splint that slides, but holds the jaw in good position.

POSSIBLE ADVANCES IN CIVIL MEDICINE SUGGESTED BY EXPERIENCES IN TREATING WAR INJURIES OF THE CHEST*

By J. L. YATES, M.D.
MILWAUKEE, WIS.

The war taught anew and emphasized as it has never before been emphasized that successful treatment entails more than preventing an immediate fatality. The other elements to be considered are the preservation of normal, local and general function, reduction in the duration of disability and protection from increased liability to subsequent disease. From this viewpoint diseases of the chest present opportunities for therapeutic progress and for wide service the equal of those offered by the rest of the body.

Preservation of the structural and functional integrity of the pleural cavity is the chief objective in medical and surgical treatment of pleuropulmonary disease or injury. This is to be achieved through the restitution of mobility of the thoracic parietes, of intrapleural negative pressure and of pulmonary elasticity. Under these conditions normal respiration and pulmonary circulation are possible, and only under these conditions can occur the sudden and wide compensatory variations required by the fluctuating activities of ordinary life.

The most important feature in both medical and surgical therapy is the prevention and relief of pleurisy. Pleurisy is the

* The work upon which this communication is based has been generously assisted by the Research Division, American Red Cross, under the direction of Dr. Alexander Lambert.

commonest indication for treatment, the most frequent cause of failure of intrathoracic operations undertaken to relieve other diseases, and, if uncontrolled, it leads to serious and often to permanent impairment of parietal mobility, intrapleural negative pressure and pulmonary elasticity—hence to some degree of incapacity.

Pleural reactions to irritation should be considered from two angles: (1) the local and general effects common to serositis, and (2) the specific effects peculiar to pleurisy.

Serositis is characterized by an abundant serofibrinous exudate and a tendency to the formation of adhesions between contiguous surfaces. Both the profuse exudate and the adhesions are natural defensive reactions, both are inevitable steps in repair, and, if uncontrolled, either may exert unfavorable influences upon ultimate recovery. An early formation of adhesions is desirable to bottle up an area of irritation, to enmesh bacteria, and thus to restrict a dissemination of irritants while local and general resistance are being developed. The earliest subsequent elimination of these adhesions is desirable and can be influenced by treatment. Adhesions are eliminated by being so gradually disrupted that the denudations produced are immediately overgrown with serosa cells. Excessive disrupting force by causing too great mechanical irritation serves to aggravate the existing lesions. Adequate force is best supplied by active motion which is controlled by reflex pain inhibition. Fibrinous adhesions are formed in four to eight hours and their organization is definite in three or four days. The most favorable time to begin active motion is when the dangers of acute infection are passed, so that the possible liberation of bacteria through tearing adhesions may be tolerated. These facts have been recognized in methods of treating peritonitis. Willems[1] and Delrez[2] have proved they are applicable to arthritis, and they hold equally well in pleurisy.

The effects of the serous exudate, which is always profuse, are determined by the rapidity of absorption. In the belly where absorption is so rapid as to amount almost to perfect drainage, there is little accumulation about or diffusion from the primary

focus of reaction, but there is danger of overintoxication. In the synovial and pleural cavities accumulation of excess exudate is the rule, because of a low rate of absorption. The lesser dangers of immediate intoxication are more than compensated by disadvantages. Accumulation of a fluid within a cavity means hypertension and a corresponding anemia; the separation of serous surfaces assures lessened resistance and greater diffusion. Serous exudates usually contain some of the original irritant and are therefore dangerous, but even though they contain none they are of themselves sufficiently irritating to induce a similar, though less active serofibrinous reaction on normal serous surfaces to which they are diffused.

The anatomical reaction of all serous surfaces is quite identical, the serosa cells exhibiting remarkably high powers of resistance and regeneration. Consequently, the explanation for the variations in resistance of different serous cavities is clear. In general the larger the cavity the more adaptable its walls; the richer the blood supply of its limiting membranes, particularly the visceral deflection, the more rapid the absorption and the higher the resistance. Natural methods of defence show the peritoneal cavity, which spontaneously prevents the separation of serous surfaces, has the highest resistance. Clinical methods, which prevent this separation of serous surfaces, or if separation has occurred produce a reapposition of these surfaces, offer the optimum opportunities for recovery Artificial drainage, introduced so as to imitate physiological absorption, is required.

The specific effects of pleuritic reactions upon parietal mobility, intrapleural negative pressure and pulmonary elasticity are equally positive indications for relief.

Parietal Mobility. Assuming integrity of bones, joints and cartilages, normal motion in the chest parietes depends upon unimpaired function of the muscle-nerve combinations concerned in producing inspiration.

Acute pleurisy causes a prompt inhibition of motion in the elevators of the ribs and in the diaphragm. The diaphragm, unlike other muscles affected reflexly by irritation of structures

with which they are associated functionally, becomes immobile in relaxation instead of contraction. Intra-abdominal pressure causes the affected side to rise to an abnormally high level. The more intense the pleurisy, the greater the degree of diaphragmatic paresis, the more prolonged the pleurisy, the greater the probability that the paresis will become paralysis. Immobility of the diaphragm is of great value in the early defence against infection, providing conditions favorable to the maximum blood supply and the most effective degree of the restriction of motion. Permanent paralysis is a handicap contributing materially to exertion dyspnea

Prevention of diaphragmatic disability is one of the most urgent demands for the early treatment of spontaneous pleurisy and for the prevention of pleurisy after thoracotomy. It is another indication for drainage.

Intrapleural Negative Pressure. Deviations from normal negative pressure cause interference with respiration and circulation. Slight reductions are evidenced by dyspnea and palpitation upon exertion Abolition of negative pressure causes asphyxia, because pulmonary inflation ceases. A small collection of fluid suffices to produce effects, because variations in pressure are not confined to one part or to one side of the chest, as Graham and Bell[3] have shown. The least harmful abnormality in negative pressure obtains so long as pleural surfaces are opposed. This argues against artificial pneumothorax as a therapeutic measure and is another indication for drainage where effusions are present.

Pulmonary Elasticity. If a portion of a lobe does not inflate normally it affects the entire lobe by acting like a splint. If the inflation of one lobe is sufficiently impeded the motion of the entire side of the chest is reduced. The longer a lung is compressed the more difficult reinflation becomes, and should atelectasis be combined with compression, reinflation soon becomes impossible. A subjacent cortical pneumonitis is constantly provoked by an acute pleurisy. Its extent and intensity varies with the intensity and duration of the pleurisy. This form of parenchymatous inflammation is almost certain to go

on to organization and becomes an additional restriction to inflation. It is relieved ultimately, as pleural adhesions are eliminated, by active motion—respiration.

Again arises the same problem, the limitation of the extent, duration and intensity of the pleurisy, and the same solution presents itself—drainage.

Up to this point an outline of the significant pleural reaction has been attempted to establish principles of treatment which shall work in conjunction with natural processes of defence and repair. Similar reactions in the lung and in the parietes remain to be considered.

Pulmonary defence and repair is more important in protecting the pleura than in safeguarding the lung parenchyma, which is one of the most resistant and smoothest healing tissues in the body. Fortunately the conditions which give the greatest protection to the pleura have the same influence upon the lung. Repair of tissue in general is fostered not so well by absolute immobilization as by the restriction of motion, which prevents too great traumatism and at the same time assures an adequate blood supply and the continuation of nerve activity. The optimum point of restricted motion for the lung occurs with a reduction in negative pressure which corresponds to that produced by an immobile diaphragm. This assertion is based upon Cloetta's[4] experiments, Middleton's experimental and clinical observations and upon the natural methods of defence in pneumonia.

Surgical repair of incisions into lung tissue should be designed to assure the immediate resumption of respiration. Adequate hemostasis and aërostasis is easily obtained. Mass suturing is not permissible; layer repair with multiple fine stitches is required. Closure of visceral pleura must be air-tight.

It is obvious that after thoracotomy the chest should be closed with the lungs inflated in order to reëstablish intrapleural negative pressure. Pulmonary inflation is best accomplished by a method of intratracheal hypertension attainable with nitrous oxide and oxygen pressure analgesia.

Repair of parietal wounds, including surgical incisions, centers in the immediate healing of parietal pleura. The smoothness of this healing so dominates the reduction of dangers of pleurisy that sacrifices must be made to obtain accurate serosa to serosa approximation and without suture tension.

The significance of these simple details in repair was established by clinical and postmortem observations upon wounded soldiers during a service at the Ambulance de l'Ocean at Lapanne and by experimentation in the Laboratory of Surgical Research at the Central Medical Department Laboratory, A. E. F.[5] At this laboratory a group detailed by Dr. Finney devised methods for practical application of the principles involved. These methods were then used in treating the wounded in advanced hospitals. During a period when the wounded were received promptly and in good condition, the immediate mortality-rate, which included two weeks after operation, was 4 per cent. This was the only period open to fair judgment, because delays in transportation at other times made the average duration from injury to operation about twenty-four hours and increased the mortality-rate ten times. These experiences, together with observation made since the war upon late results obtained in the wounded and in civil practice, indicate possibilities of progress along certain lines of treatment.

Early drainage in acute pleurisy and primary drainage at the time of thoracotomy have been discredited because of faulty methods employed, and not because drainage under these conditions is contra-indicated by its antagonism to physiological processes. Willems and Delrez showed that joint drainage by simple arthrotomy and early active motion, to furnish the expulsive force and to eliminate adhesions, gave recovery with splendid function. Simple air-tight one-way drainage of the chest, employing the increased intrathoracic pressure of inspiration and of coughing as expulsive and disrupting forces, is similarly effective. Suction should not be used. The proper intercostal insertion of a catheter by means of a trocar and cannula is hardly more serious than a thoracocentesis and provides constant drainage,

with minimum irritation. Bowditch first showed what early and repeated aspiration could accomplish in the treatment of pleurisy.

A catheter drain armed with a one-way flap valve, inserted when pleurisy is incipient, is only a continuation of Bowditch's teaching. This modification will be accepted when two facts are recognized. The first is that an early diagnosis of serofibrinous pleurisy can be made and fluoroscopically confirmed before it is possible to aspirate fluid with certainty without the aid of a fluoroscope. This stage corresponds to early acute appendicitis. The second is that empyema which is a late stage of serofibrinous pleurisy is as flattering a commentary upon clinical methods as is purulent peritonitis arising from appendicitis. Both are confessions of therapeutic failure. Even after empyema has developed catheter drainage should be tried first, with or without lavage with Dakin's solution, as conditions demand. This simple treatment may obviate open operation, and will usually reduce its magnitude if it become indicated later.

Primary drainage after laparotomy was found to be harmful because the general peritoneal cavity cannot be drained, and because all forms of drains increased instead of reduced intraperitoneal irritation. Primary drainage after thoracotomy has been discredited because it did not preserve intrapleural negative pressure and therefore assured pulmonary collapse. Drainage of the pleural cavity is easy and pleural irritation slight if the tube is introduced so as to avoid undue contact with the visceral pleura. Thoracotomy is invariably followed by serous effusion, which is so extensive as to be easily demonstrable on the second or third day. Its dangers are so definite that many of the best surgeons follow Bowditch's teaching by having their patients aspirated as a routine at this time. The aspirations are repeated at intervals until fluid disappears.

All intrathoracic surgical operations can be performed under nitrous oxide and oxygen analgesia, and the degree of inflation or deflation of the lung can be suited to the operative requirements. This method, developed by Dr J. T. Gwathmey's

following up a lead given by Dr. Crile, is superior in doing away with deeper narcosis required to introduce intratracheal or intrapharyngeal tubes and utilizes the cylinder pressure of the gases instead of any more or less elaborate apparatus to provide differential pressure. Above all it is safe if used with reasonable care.

The significance of diaphragmatic relaxation in protecting the repair in lung and pleura is not appreciated. It is a natural method of defence and should be induced therapeutically. For instance, if the phrenic nerve be blocked by injecting 1 per cent. cocain in the early steps of a thoracotomy the operation is facilitated by reduced motion and the recovery after operation is more certain, more rapid and less distressing. This paralysis lasts four or five days and then gradually disappears. The pain incidental to pleurisy caused by malignant growths can be materially reduced by dividing the phrenic in the neck or injecting it with alcohol. Possibly the most important indication for inducing diaphragmatic palsy is in the treatment of pulmonary tuberculosis of the type now combated with artificial pneumothorax and for reasons stated above. Individuals with diffuse pleural adhesions which make artificial pneumothorax impossible could be given the same advantage. The injection of alcohol into the cervical trunk of the phrenic in concentrations suitable to the desired duration of paralysis can be done easily under local anesthesia. Dogs are little embarrassed if both phrenic nerves are blocked, so possibly the diaphragm may be paralyzed on both sides in treating the tuberculous with advancing bilateral lesions. There is no evidence that a paralyzed diaphragm seriously interferes with the raising and expectoration of morbid bronchial secretions.

These principles applied to surgical methods make thoracotomy a safe operation because they afford a control of pleurisy and protect respiration and circulation. It were folly to attempt to predict the attainments of intrathoracic surgery in the immediate future, so great are its possibilities.

The same principles applied by internists will reduce the incidence of empyema, relieve much of the distress of tuberculous

pleurisy and probably improve the results obtained in treating pulmonary tuberculosis.

An increasing recognition of the frequency of impaired diaphragmatic function resulting from slight attacks of pleurisy indicates the greater attention which must be given to the prevention of late complications by early active motion of the lungs as soon as curtailment of the acute process permits. The importance of deep and free respiration becomes more and more evident. Preventive and therapeutic measures to obtain desired results are determined by thoracic physiology. Much remains to be learned, and there is scarcely a laboratory or clinical worker who can avoid finding some suggestion for renewed activity if the problem is considered broadly.

The demand for man power during the war caused the development of methods of treatment which would return the wounded to duty in the least time and competent for indefinite service. The demands of peace times are the same, though the recognition is less general. There is not one law of tissue repair for war and another for peace. Function will always depend upon tissue integrity. If the knowledge of repair gained by war medicine is applied to civil practice, and with the same end in view, the death, the distress and disability prevented will soon exceed that caused by the conflict.

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15
OCT
1920

INDEX

A

Abscess, postinfluenzal, of the sheath of the rectus muscle, 476
Address of the President, 1
Amputations and stumps, 210
Ashhurst, A. P. C., lessons learned in military surgery, 59

B

Balfour, D. C., life expectancy of patients following operations for gastric and duodenal ulcers, 372, 394
Bevan, A. D., cancer of the stomach, 390
Blake, J. A., closure of thoracic sinuses, 158
    cranioplasty, 206
Bloodgood, J. C., transplantation of the rectus muscle, 463
Brewer, G. E., lessons learned in military surgery, 58
Buchanan, J. J., foreign bodies in the stomach, 365
Bunts, F. E., cancer of the stomach, 391
    treatment of wounds of the knee-joint, 104

C

Chest, gunshot wounds of the, 123
Codman, E. A., abscess of the sheath of the rectus muscle, 482
Coley, W. B., conservative treatment of sarcoma of the long bones, 273
Cotton, F. J., amputations and stumps, 210
Cranioplasty, 174
Crile, G. W., treatment of war wounds, 35

D

Dandy, W. E., experimental hydrocephalus, 397
Darrach, W., abscess of the sheath of the rectus muscle, 482
Deaver, J. B., operative treatment of peptic ulcer, 367, 395

Depage, A., closure of thoracic sinuses, 154, 159
lantern-slide demonstration of jaw surgery, 505
treatment of war wounds, 15
Diplegia, traumatic facial, 494
Duodenal and gastric ulcers, 372

E

Eliot, E., treatment of gunshot wounds of the chest, 123, 132
Empyema and thoracic fistula, 134

F

Femur, fractures of, 162
Finney, J. M. T., organization and operation of an evacuation hospital, 352
Fistula, thoracic and empyema, 134
Fistulæ, arteriovenous and lymphaticovenous, 262
Fractures of the lower third of the femur, 162
Frazier, C. H., peripheral nerve injuries, 226, 240

G

Gage, H., cancer of the stomach, 393
postinfluenzal abscess of the sheath of the rectus muscle, 476
Gastric and duodenal ulcers, 372
Gibbon, J. H., closure of thoracic sinuses, 154
foreign bodies in the stomach, 366
no-flap or guillotine amputation, 52
Gibson, C. L., cancer of the stomach, 392
result of six years' follow-up system in a surgical service, 429
Groves, E. W. H., cranioplasty, 204
Guillotine amputation, 52, 55
Gunshot wounds of the chest, 123

H

Halsted, W. S., arteriovenous and lymphaticovenous fistulæ, 262
Harte, R. H., surgical problems in nerve injuries, 240
Hetzel, W. B., knee-joint war injuries, 91
Hospital, evacuation, organization and operation of, 337
Huntington, T. W., cranioplasty, 207
lessons learned in military surgery, 56
Hydrocephalus, experimental, 397

I

Injuries, war, 91
Inthrathoracic projectiles, late extraction of, 146, 160

J

Jaw surgery, 505
Jopson, J. H., treatment of recent wounds of the knee-joint, 61, 104

K

Keen, W. W., a case in which a woman defecated, urinated and menstruated by the rectum, 258
Knee-joint war injuries, 91

L

Lane, A., cranioplasty, 208
Laparotomy, transthoracic, 106
Leary, T. J., organization and operation of an evacuation hospital, 337
Le Conte, R. G., delayed extraction of projectiles by method of Petit de la Villéon, 146, 160
Lewis, D. organization and operation of an evacuation hospital, 337
Lilienthal, H., cancer of the stomach, 391
    gunshot wounds of the chest, 132
    lessons learned in military surgery, 59
    thoracic fistula and empyema, 134, 159
Lower, W. E., slightly wounded in military and civilian practice, 38
Lyle, H. H. M., lessons learned in military surgery, 57

M

Macrae, Jr., D., organization and operation of an evacuation hospital, 352
Mayo, C. H., cancer of the stomach and its surgical treatment, 378, 396
Mayo, W. J., foreign bodies in the stomach, 365
    results of splenectomy in the anemias, 483
McWilliams, C. A., knee-joint war injuries, 91
Meyer, W., closure of thoracic sinuses, 155
    foreign bodies in the stomach, 365
    transthoracic laparotomy, 106
Mixter, S. J., foreign bodies in the stomach, 365
Moschcowitz, A. V., closure of thoracic sinuses, 154
    lessons learned in military surgery, 56

N

NERVE injuries, 226
No-flap or guillotine operation, 52

O

OBITUARIES:
Mears, J. Ewing, xli
Kocher, Theodor, xliii
Davis, Gwilym George, xlv
Moore, James Edward, xlvi
Ochsner, A. J., closure of thoracic sinuses, 157
Organization and operation of an evacuation hospital, 337

P

PEPTIC ulcer, operative treatment of, 367
Peripheral nerve injuries, 226
Pilcher, L. S., influence of war surgery upon civil practice, 1
Pool, E. H., treatment of recent wounds of the knee-joint, 61
Porter, M. F., cancer of the stomach, 391
Powers, C. A., closure of thoracic sinuses, 157
cranioplasty, 209
phases of war surgery, 166
President, address of the, 1
Primrose, A., cranioplasty, 174

R

RANSOHOFF, J., closure of thoracic sinuses, 157
traumatic facial diplegia, 494
Rectus muscle, transplantation of, 463
Roberts, J. B., salvage of the hand by timely reparative surgery, 242

S

SALVAGE of the hand by reparative surgery, 242
Sarcoma of the long bones, 273
Splenectomy in the anemias, 483
Stewart, F. T., transthoracic laparotomy, 121
Stewart, W. H., transthoracic laparotomy, 121
Stomach, foreign bodies in, 355
Stumps and amputations, 210
Surgeons in the recent war, experience of, 44
Surgical service, follow-up service in, 429

T

THORACIC fistula, 134
Transthoracic laparotomy, 106

U

ULCERS, gastric and duodenal, 372
Urination and menstruation by the rectum, 258

V

VAN DE VELDE, J., fractures of the lower third of the femur, 162
Vander Veer, E. A., experience gained by surgeons in the recent war, 44

W

WALKER, J. B., cranioplasty, 206
War surgery, 1
phases of, 166
wounds, 15
treatment of, 35
Winslow, R., foreign bodies in the stomach, 355
Wounded in military and civilian practice, 38
Wounds of the knee-joint, 61

Y

YATES, J. L., possible advances in civil medicine suggested by experiences in treating war injuries of the chest, 506